Annual Water Quality Report

EASTMAN LAKE

Water Year 2001

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I DISCUSSION

Eastman Lake

2001 Results

The dissolved oxygen, water temperature, and pH profiles are shown on the attached figures in Section II. In the summer of 2001, temperature stratification existed, with the lake bottom temperatures measured at 50 degrees and the surface temperature rising to 60 degrees. Dissolved oxygen depletion occurred in the hypolimnion or bottom layer of the lake during the summer which indicate that organic decomposition is occurring at the bottom of Eastman Lake and therefore the use of Eastman Lake as a cold water fishery is questionable. However, since the dissolved oxygen is relatively high on the surface, the lake will serve well as a warm water fishery.

The DO, temperature and pH profile changed very little from 2000. The summer phytophankton biomass increased from 2.7 mg/L in 2000 to 8.2 mg/L in 2001. This amount of phytophankton biomass is not considered a problem and it should be noted that levels of phytophankton will vary from year to year and will be monitored continuously to determine if eutrophication is occurring.

Eutrophication is the slow natural process in which a Lake moves from an oligotrophic condition to a mesotrophic condition then to a eutrophic condition. Oligotrophic waters contains low concentrations of essential nutrients such as nitrogen, phosphorus and iron and therefore life forms are generally present in small numbers.

Lake Tahoe and Crater Lake in Oregon are examples of oligotrophic waters. Natural input of nutrients from runoff results in a gradual increase of phytophankton and higher life forms. This results in the transformation of oligotrophic waters into Mesotrophic waters which are characterized by the abundance of life forms at all levels. However, continued inflow of nutrients can further change the Mestrophic waters into Eutrophic waters which are characterized by high algae growth, high turbidity, and fewer species due to lower dissolved oxygen levels. The algue blooms and scarce fish makes Eutrophic waters less desirable. This process may occur over a long period of time but human activities almost always accelerate this process. One of the major goal of the water quality program is to reduce or mitigate the human effects on the eutrophication process. This requires a monitoring program to determine the levels of nutrient input and phytoplanton levels. The individual species within each individual phytoplankton group are shown in Section IV.

The nutrient, alkalinity and chemical oxygen demand (COD) data shown in Section V indicates that excessive nutrients are not present in Eastman Lake that would cause undesirable phytoplankton blooms, that the lake water is well buffered and there is not an excess of oxygen-demanding substances in the inflows. The recent increase in phytoplanton from 2000 to 2001 is not a major concern since 8.1 mg/L is still relatively low.

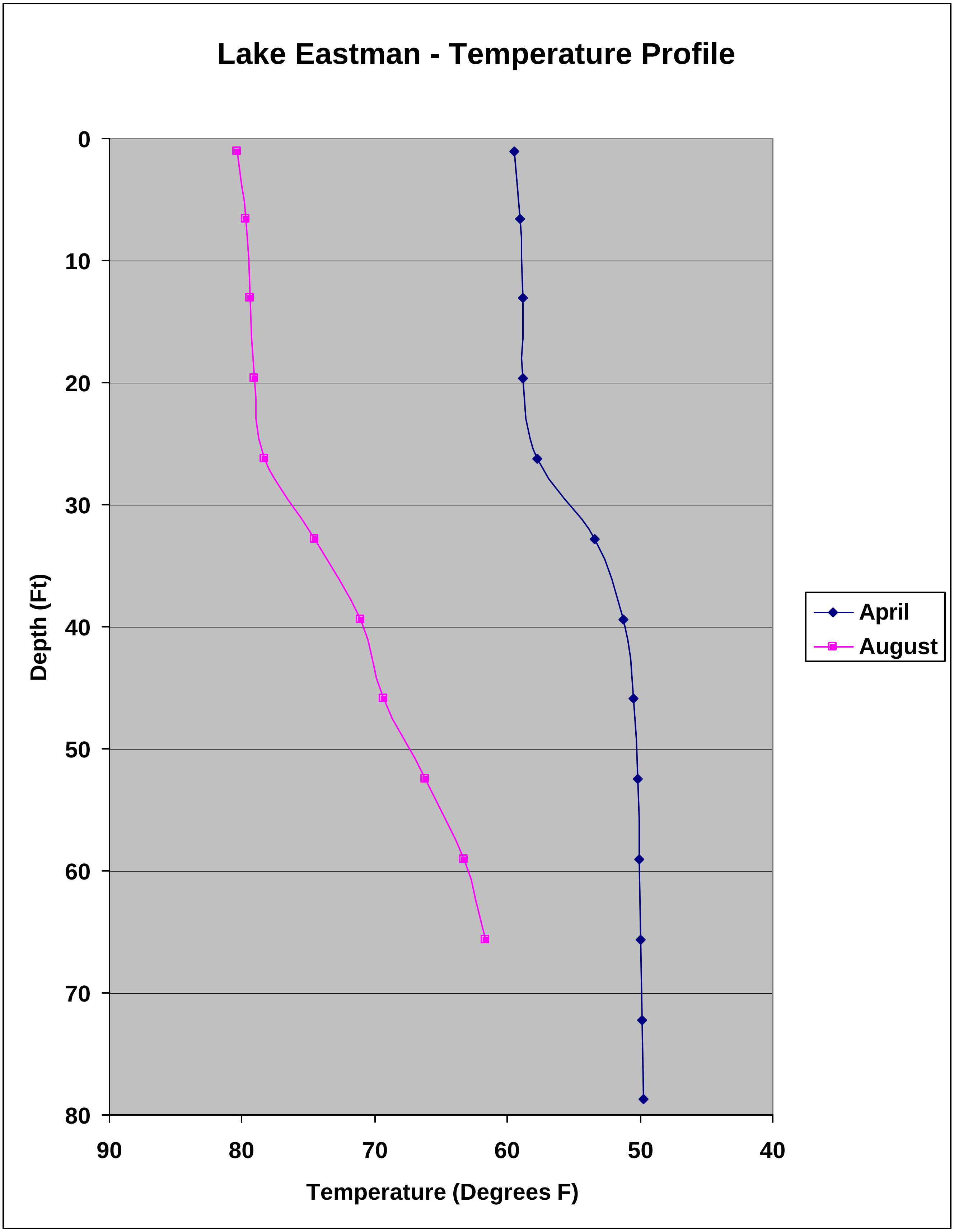
For 2001, the dissolved heavy metals did not exceed the drinking water standard or the freshwater fishery criteria during either the Spring or Summer except for dissolved manganese and dissolved mercury at the bottom of the lake. The graphs are shown in Section V for the surface and bottom waters of the Lakes and it's inflows and outflows.

Dissolved mercury levels of 0.035 ppb found on the lake bottom for Summer 1999 and this exceeded the fish aquatic life criteria of 0.012 ppb. Methyl mercury is a concern since it can bioaccummulate in fish tissue. Based on mercury levels found in 1999, a fish tissue program was initiated for the first time in 2000. The results from one catfish that was collected on Nov 1, 2000 resulted in a total mercury level of 0.089 ppm. The bioaccummulation factor is therefore approximately 1780 (based on 89 ppb in tissue / 0.05 ppb in water in 1999). The 0.089 ppm result is less than the FDA criteria of 1 ppm for a fish advisory and less than the EPA action level of 0.3 ppm to continue monitoring. Due to these low level of mercury in fish tissue, the fish tissue program was discontinued at Lake Eastman. At the end of Section VI are the EPA fact sheets on mercury in fish tissue.

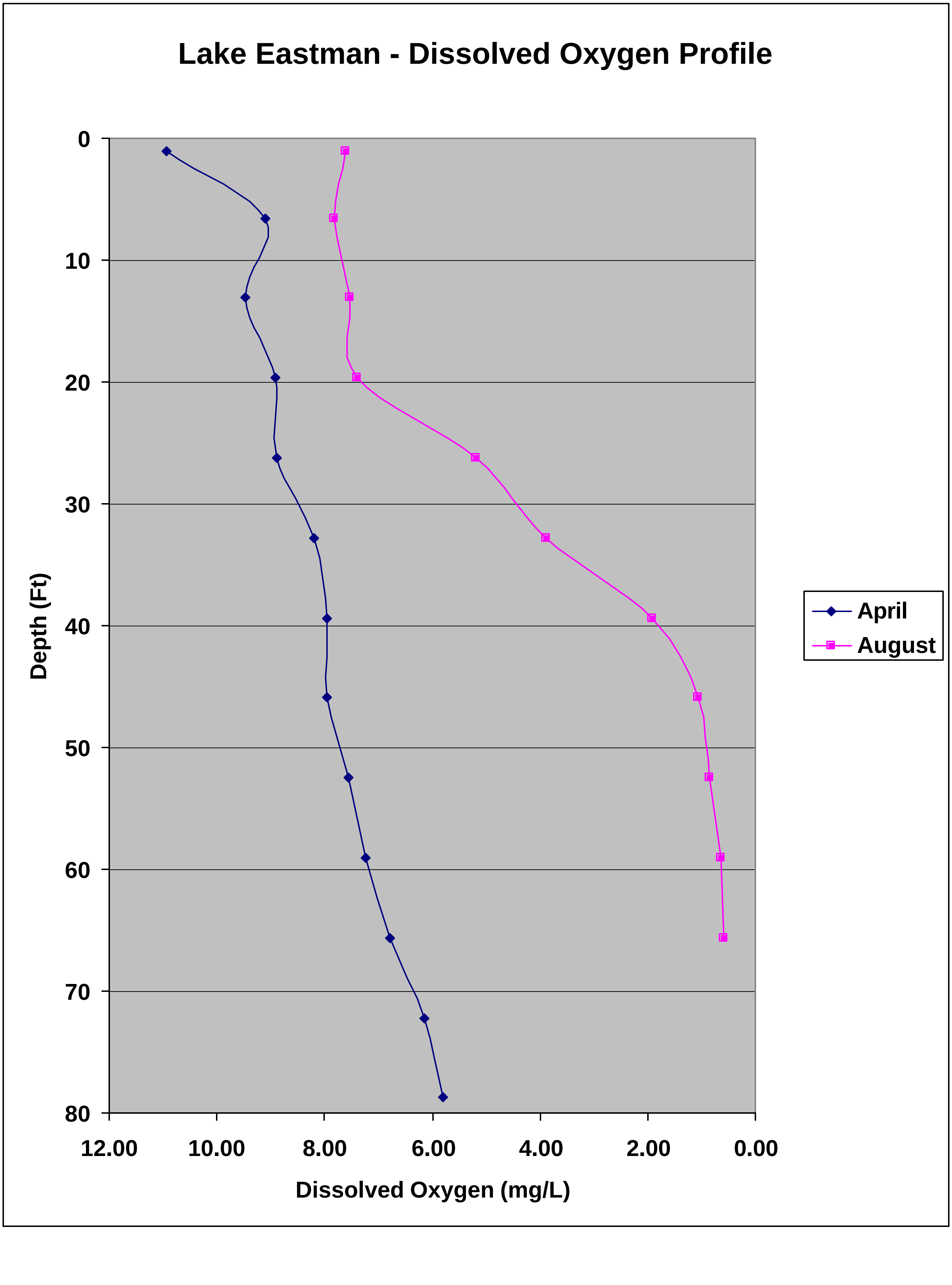
The MTBE results for 2000 were non-detectable levels for the spring of 2000 and non-detectable levels of MTBE for surface water near the dam and near the marina in the summer of 2000. The laboratory detection limit is 2 ppb. For 2001, the MTBE results were 0.4 ppb in the Spring and 3 ppb in the Summer. The 2001 results are considered average when compared to the other lakes and the results are provided in Section VII. At the end of Section VII is the EPA fact sheet on MTBE in drinking water. Unlike mercury, which has a known toxic effect on humans, there is little data connecting MTBE to human toxicity. However, since MTBE is considered controversial, it is recommended that MTBE data be continued to be collected.

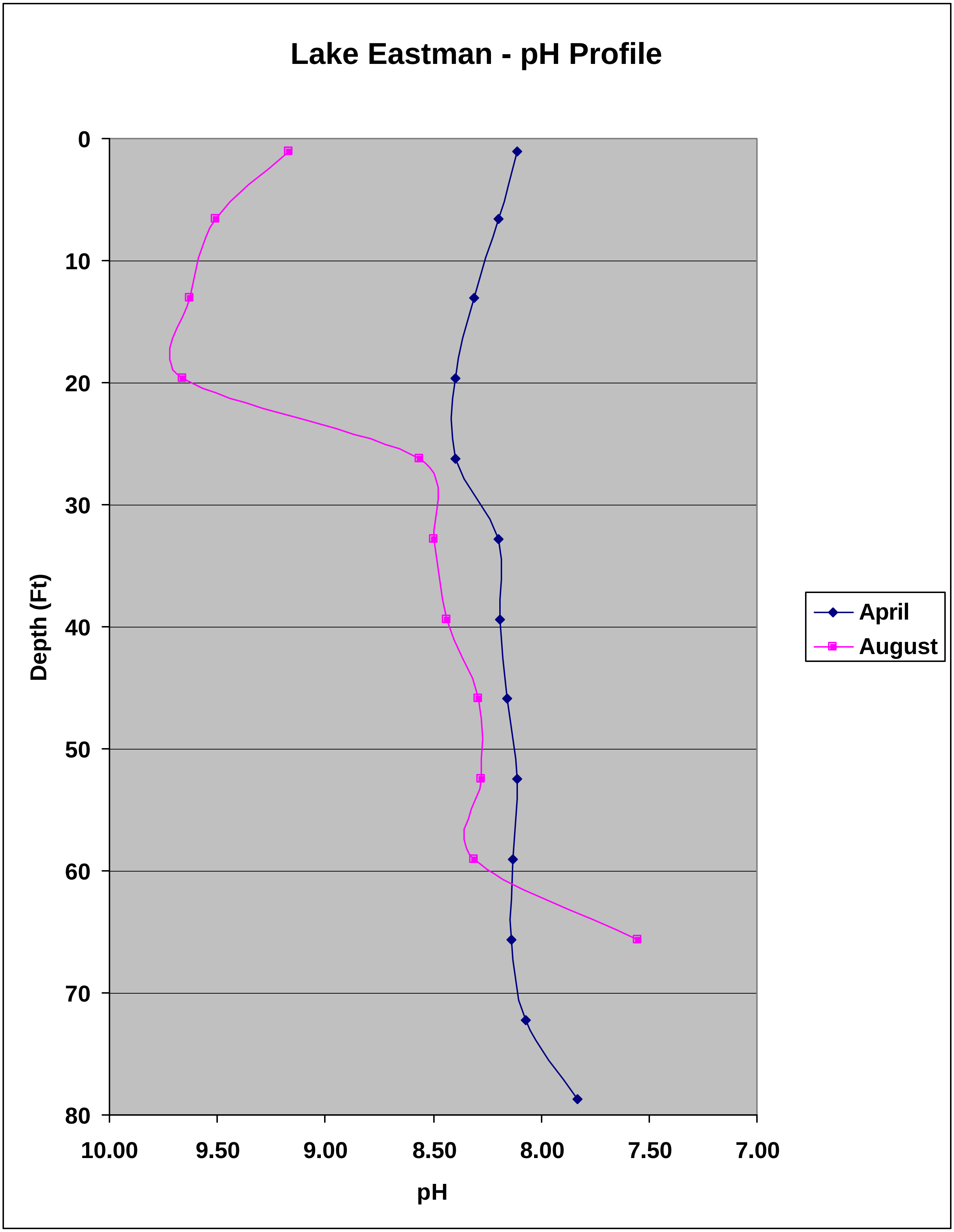
In summary, Eastman Lake has very low levels of contaminants and very few water quality problems compared to the other lakes. Only dissolved mercury and dissolved manganese exceeded the drinking water standard and fish criteria at the bottom of the lake. The other elements also do not indicate any significant problem but will continue to be monitored in the future.

II Temperature/pH/DO profile



Lake Eastman - Temperature Profile
0
10
20
30
40
50
60
70
80
Depth (Ft)
90
80
70
60
50
40
Temperature (Degrees F)
April
August


Lake Eastman - Dissolved Oxygen Profile
Depth (Ft)
0
10
20
30
40
50
60
70
80
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Dissolved Oxygen (mg/L)
April
August

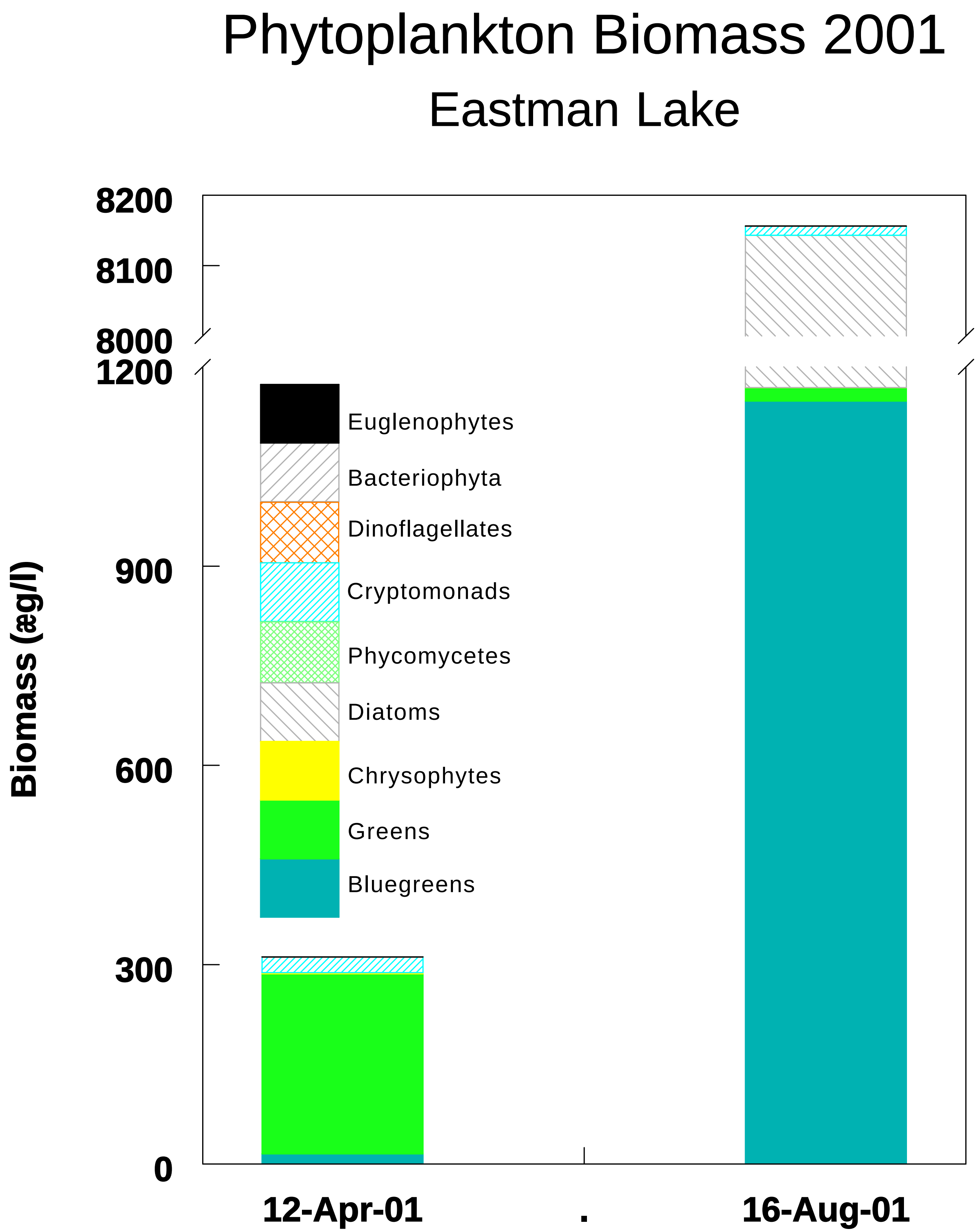


Lake Eastman - pH Profile
Depth (Ft)
0
10
20
30
40
50
60
70
80
10.00
9.50
9.00
8.50
8.00
7.50
7.00
pH
April
August

EASTMAN					
Sample Location: Behind dam				**Date:** 04/12/01	
Observers: Tim McLaughlin				**Time:** 9:30 am	
Lake Elevation: 537.51					
Weather Conditions:					
Wind Speed: 0		**Precipitation:** 0		**Temp (F):** 60	
SECCHI Depth:					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
23.1	78.7	9.88	149	5.81	7.83
22	72.2	9.92	148	6.15	8.07
20	65.6	9.95	148	6.78	8.14
18	59.1	10.01	149	7.25	8.13
16	52.5	10.07	149	7.55	8.11
14	45.9	10.26	151	7.96	8.16
12	39.4	10.70	151	7.95	8.19
10	32.8	11.87	151	8.19	8.20
8	26.2	14.33	156	8.90	8.40
6	19.7	14.93	155	8.91	8.40
4	13.1	14.90	155	9.46	8.31
2	6.6	15.00	155	9.11	8.20
0.03	1	15.28	154	10.93	8.11
CHOWCHILLA (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs)**
54.2	7.7		-	-	-
VISUAL OBSERVATIONS:					

EASTMAN					
Sample Location: Behind dam				**Date:** 08/16/01	
Observers: Tim McLaughlin				**Time:** 9:30 am	
Lake Elevation: 496.05					
Weather Conditions:					
Wind Speed: 5		**Precipitation:** 0		**Temp (F):** 75	
SECCHI Depth: 3 feet and 9 inches					
Depth-M	**Depth-F**	**Temp-C**	**Cond**	**DOmg/L**	**pH**
19.2	65.6	16.46	184	0.58	7.55
18	59.1	17.39	184	0.65	8.31
16	52.5	18.97	187	0.85	8.28
14	45.9	20.72	188	1.06	8.29
12	39.4	21.69	192	1.92	8.44
10	32.8	23.64	193	3.89	8.50
8	26.2	25.71	197	5.20	8.56
6	19.7	26.17	197	7.40	9.66
4	13.1	26.31	197	7.53	9.63
2	6.6	26.52	198	7.83	9.51
0.03	1	26.85	198	7.62	9.17
CHOWCHILLA (Inflow)					
Temp (F)	**pH**		**DOmg/L**	**EC**	**Flow rate (cfs)**
72.8	6.57		-	-	-
VISUAL OBSERVATIONS: Lots of floating algae, hydrogen sulfide smell.					

III Phytoplankton


Phytoplankton Biomass 2001
Eastman Lake
Biomass (æg/l)
8200
8100
8000
1200
900
600
300
0
Euglenophytes
Bacteriophyta
Dinoflagellates
Cryptomonads
Phycomycetes
Diatoms
Chrysophytes
Greens
Bluegreens
12-Apr-01
.
16-Aug-01

Phytoplankton Normalized Sample Summary
Army Corps of Engineers - Standard samples

Sample location: **Eastman Lake / Buchanan Dam**
Sample description:
Sampled on **04/12/01** **by AC**
Sample type: **Composite** **Cm settled: 1.30**

Species	Species name	Group	Units/L	BioVol (µg/L)
ANKYJU	Ankyra judayi	Chlorophytes	794626	242.361
KOLISL	Koliella spiculiformis	Chlorophytes	122880	9.794
STAURP	Staurasturm planctonicum	Chlorophytes	769	19.110
		Chlorophytes Totals:	918275	271.265

Species	Species name	Group	Units/L	BioVol (µg/L)
FLAGSM	Flagellates (<5µm)	Chrysophytes	106496	1.597
		Chrysophytes Totals:	106496	1.597

Species	Species name	Group	Units/L	BioVol (µg/L)
CRYPT	Cryptomonas sp.	Cryptomonads	16923	18.355
CRYPTM	Cryptomonas marssonii	Cryptomonads	10000	3.520
RHODOM	Rhodomonas lacustris	Cryptomonads	16384	1.819
		Cryptomonads Totals:	43307	23.694

Species	Species name	Group	Units/L	BioVol (µg/L)
ANABSP	Anabaena spiroides	Cyanophytes	19231	0.852
APHANI	Apanizomenon flos-aque	Cyanophytes	67692	14.283
		Cyanophytes Totals:	86923	15.135

Sample total: 311.691

Phytoplankton Normalized Sample Summary
Army Corps of Engineers - Standard samples

Sample location: **Eastman Lake / Buchanan Dam**
Sample description:
Sampled on **08/16/01** **by AC**
Sample type: **Composite** **Cm settled: 0.50**

Species	Species name	Group	Units/L	BioVol (mg/L)
KOLISL	Koliella spiculiformis	Chlorophytes	95847	7.639
OOCYEL	Oocystis elliptica	Chlorophytes	16000	8.040
SPHAER	Sphaerocystis schroeteri	Chlorophytes	80000	4.536
		Chlorophytes Totals:	191847	20.215

Species	Species name	Group	Units/L	BioVol (mg/L)
CRYPT	Cryptomonas sp.	Cryptomonads	2000	2.786
RHODMN	Rhodomonas minuta	Cryptomonads	255591	10.224
		Cryptomonads Totals:	257591	13.010

Species	Species name	Group	Units/L	BioVol (mg/L)
ANABSP	Anabaena spiroides	Cyanophytes	3968000	175.782
APHANI	Apanizomenon flos-aque	Cyanophytes	1122000	236.742
CHROTU	Chroococcus turgidus	Cyanophytes	64000	338.074
NOSTOC	Nostoc sp.	Cyanophytes	24792683	49.585
OSCILI	Oscillatoria limosa	Cyanophytes	206000	348.243
		Cyanophytes Totals:	30152683	1148.426

Species	Species name	Group	Units/L	BioVol (mg/L)
CYCSTE	Cyclotella stelligera	Diatoms	31949	2.939
FRAGCR	Fragilaria crotonensis	Diatoms	2036000	3542.436
MELOG	Aulacosira granulata	Diatoms	1360000	2580.328
MELOGA	Aulacosira granulata v. angustissima	Diatoms	834000	849.012
		Diatoms Totals:	4261949	6974.715

Sample total: 8156.366

IV Nutrient and Miscellaneous Parameters

2001 Lake Monitoring Results for Organics

Pesticides and Herbicides were discontinued in 2001 since the results from 1995 to 2000 were consistently “non-detect” and the program’s current effort is to focus on MTBE and mercury levels in fish tissue.

The following tables on the next page are the 2001 Lake Monitoring Results for general Organics related to nutrients (which may cause algue blooms) and miscellanous water quality parameters which may have an adverse impact on aquatic life such as Chemical Oxygen Demand and ammonia (which may cause a fish kill).

The results in the following tables indicate no potential for signficant adverse impact.

Notes:
Alkalinity is reported as “Total Alkalinity as CaCO3”
Ammonia is reported as “Ammonia as N”
Nitrate is reported as “Nitrate + Nitrate as N”
Total P is reported as “Phosphate as P. total”
Ortho P is reported as “Phosphate as P. Ortho”
Kjedahl N is reported as “Total Kjedahl Nitrogen”
COD is “Chemical Oxygen Demand”
Tot Solids is reported as “Solids, Tot”

Lake codes are as follows:

BB	Black Butte
EA	Eastmand
EN	Englebright
HE	Hensley
IS	Isabella
KA	Kaweah
MC	Martis Creek
ME	Mendocino
NH	New Hogan
PF	Pine Flat
SO	Sonoma
SU	Success

Inorganic Results (mg/L) For surface lake waters (spring)

	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	120	50	40	30	60	40	60	80	70	10	70	120
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1
Chloride	12	20	5	18	5	<1	3	2	7	1	3	6
Nitrate	<0.1		<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	<0.1
Total P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1			<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		<0.1
Sulfate	15	2	3.6	4	7.8	1.8	1	7	8.5	2	6	4.8
Kjeldahl N	0.3	<0.1	<0.1	0.3	0.3	0.2	.4	0.3	0.3	0.2	0.3	0.3
COD		<50		<50	<50	<50	<50			<50		<50
Tot Solids	180	100	70	100	100	70	100	40	110	30	99	170

Inorganic Results (mg/L) For inlet waters to the lakes (spring) (I-1 only)

	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	110	50	40	30	40	20	40	80	90	10	100	50
Ammonia	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2
Chloride	10	15	5	19	2	<1	<1	2	9	1	4	1
Nitrate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total P		<0.1		<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulfate	13	0.9	2.1	2	4.8	0.8	<1	8	12	2	10	3.3
Kjeldahl N	0.1	0.2	<0.1	0.2	0.8	0.3	0.4	0.2	0.2	0.1	0.2	0.4
COD		<50	<50	<50	<50	<50		<50	<50	<50	<50	<50
Tot Solids	160	120	60	100	80	50	70	110	130	90	140	110

Inorganic Results (mg/L) For surface lake waters (summer)

	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	130	60	40	50	50	40	80	90	80	20	<10	120
Ammonia	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1		0.1
Chloride	20	14	<1	11	2	5	6	6	4	<1	7	8
Nitrate	<0.1	<0.1	<0.1	<0.1	<0.1	0.2	1.4		<0.1	0.1		0.1
Total P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ortho P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulfate	13	1.7	2.6	1.8	4	1.5	<0.5		9.4	1	6.4	2.9
Kjeldahl N	0.2	0.7	<0.1	0.5	0.3	0.2	1.7		0.2	0.2		0.5
COD	<50	<50	<50	<50	<50		<50	<50	<50	<50	<50	
Tot Solids	190	120	59	100	90	70	120	120	110	30	99	170

Inorganic Results (mg/L) For inlet waters to the lakes (summer) (I-1 only)

	BB	EA	EN	HE	IS	KA	MC	ME	NH	PF	SO	SU
Alkalinity	150	100	40		60	50		90	100	20		
Ammonia												
Chloride	15	360	<1		4	5	3	7	6	1		
Nitrate												
Total P												
Ortho P												
Sulfate	9.8	3.5	2.3		5.9	1.9		3.2		2.2		
Kjeldahl N												
COD												
Tot Solids	190	1000	60		100	90	110	120	150	40		

Caltest
ANALYTICAL LABORATORY
ENVIRONMENTAL ANALYSES

LAB ORDER No.: B040312

INORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
LAB NUMBER: B040312-1 SAMPLE ID: HE-SP-S SAMPLED: 11 APR 01 10:30								
Phosphate as P, Ortho	ND	0.1	mg/L	1	365.2	04.12.01	I010031PHO	
LAB NUMBER: B040312-3 SAMPLE ID: HE-SP-I SAMPLED: 11 APR 01 12:30								
Phosphate as P, Ortho	ND	0.1	mg/L	1	365.2	04.12.01	I010031PHO	
LAB NUMBER: B040312-4 SAMPLE ID: EA-SP-I SAMPLED: 11 APR 01 14:25								
Phosphate as P, Ortho	ND	0.1	mg/L	1	365.2	04.12.01	I010031PHO	

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Caltest ANALYTICAL LABORATORY

ENVIRONMENTAL ANALYSES

LAB ORDER No.: B040329

INORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
LAB NUMBER: B040329-8 (continued)								
Solids, total	100.	10.	mg/L	1	160.3	04.16.01	I010005TS	
Sulfate	2.	1.	mg/L	2	300.0	05.02.01	I010059IC	
Total Kjeldahl Nitrogen	0.2	0.1	mg/L	1	351.3	04.18.01	I010033TKN	
LAB NUMBER: B040329-9								
SAMPLE ID: EA-SP-I								
SAMPLED: 11 APR 01								
Arsenic, dissolved	ND	0.004	mg/L	1	200.7	04.26.01	A010396ICP	1
Cadmium, dissolved	ND	0.001	mg/L	1	200.7	04.26.01	A010396ICP	1
Calcium, dissolved	16.	0.5	mg/L	1	200.7	04.26.01	A010396ICP	1
Chromium, dissolved	ND	0.005	mg/L	1	200.7	04.26.01	A010396ICP	1
Copper, dissolved	ND	0.005	mg/L	1	200.7	04.26.01	A010396ICP	1
Iron, dissolved	0.06	0.05	mg/L	1	200.7	04.26.01	A010396ICP	1
Lead, dissolved	ND	0.003	mg/L	1	200.7	04.26.01	A010396ICP	1
Magnesium, dissolved	3.5	0.5	mg/L	1	200.7	04.26.01	A010396ICP	1
Manganese, dissolved	J0.005	0.005	mg/L	1	200.7	04.26.01	A010396ICP	1,2
Potassium, dissolved	2.	1.	mg/L	1	200.7	04.26.01	A010396ICP	1
Selenium, dissolved	J0.002	0.01	mg/L	1	200.7	04.26.01	A010396ICP	1,2
Sodium, dissolved	14.	1.	mg/L	1	200.7	04.26.01	A010396ICP	1
Zinc, dissolved	ND	0.02	mg/L	1	200.7	04.26.01	A010396ICP	1
Chemical Oxygen Demand	ND	50.	mg/L	1	410.4	04.16.01	B010110COD	
Solids, Suspended	ND	3.	mg/L	1	160.2	04.14.01	B010106TSS	
ALKALINITY				1	310.1	04.15.01	I010020ALK	
Bicarbonate as CaCO3	50.	10.	mg/L					
Hydroxide as CaCO3	ND	10.	mg/L					
Carbonate as CaCO3	ND	10.	mg/L					
Total Alkalinity as CaCO3	50.	10.	mg/L					
Ammonia as N	ND	0.1	mg/L	1	350.2	04.17.01	I010046AMM	
Chloride	15.	1.	mg/L	1	SM4500	05.15.01	I010001CHL	
Nitrate + Nitrite as N	ND	0.1	mg/L	1	353.2	05.08.01	I010021NNO	3
Phosphate as P, Total	ND	0.1	mg/L	1	365.2	04.15.01	I010033PHO	
Solids, Dissolved	140.	10.	mg/L	1	160.1	04.17.01	I010028TDS	
Solids, total	120.	10.	mg/L	1	160.3	04.16.01	I010005TS	
Sulfate	J0.9	1.	mg/L	2	300.0	05.09.01	I010062IC	2
Total Kjeldahl Nitrogen	0.2	0.1	mg/L	1	351.3	04.18.01	I010033TKN	

1) Sample Preparation on 04-26-01 using 200.2 (Filtrate)
2) A "J" flagged result reflects a value seen below the Reporting Limit (RL), but above the Method Detection Limit (MDL).
3) Sample Preparation on 04-30-01

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Caltest

ANALYTICAL LABORATORY

ENVIRONMENTAL ANALYSES

INORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
LAB NUMBER: B040329-10								
SAMPLE ID: EA-SP-S								
SAMPLED: 12 APR 01								
Arsenic, dissolved	ND	0.004	mg/L	1	200.7	04.26.01	A010396ICP	1
Cadmium, dissolved	ND	0.001	mg/L	1	200.7	04.26.01	A010396ICP	1
Calcium, dissolved	14.	0.5	mg/L	1	200.7	04.26.01	A010396ICP	1
Chromium, dissolved	ND	0.005	mg/L	1	200.7	04.26.01	A010396ICP	1
Copper, dissolved	ND	0.005	mg/L	1	200.7	04.26.01	A010396ICP	1
Iron, dissolved	J0.03	0.05	mg/L	1	200.7	04.26.01	A010396ICP	1,2
Lead, dissolved	ND	0.003	mg/L	1	200.7	04.26.01	A010396ICP	1
Magnesium, dissolved	3.5	0.5	mg/L	1	200.7	04.26.01	A010396ICP	1
Manganese, dissolved	J0.005	0.005	mg/L	1	200.7	04.26.01	A010396ICP	1,2
Mercury, Trace Level	0.6	0.5	ng/L	1	1631	05.01.01	A010415MER	3
Potassium, dissolved	3.	1.	mg/L	1	200.7	04.26.01	A010396ICP	1
Selenium, dissolved	J0.002	0.01	mg/L	1	200.7	04.26.01	A010396ICP	1,2
Sodium, dissolved	11.	1.	mg/L	1	200.7	04.26.01	A010396ICP	1
Zinc, dissolved	ND	0.02	mg/L	1	200.7	04.26.01	A010396ICP	1
Chemical Oxygen Demand	ND	50.	mg/L	1	410.4	04.16.01	B010110COD	
ids, Suspended	ND	3.	mg/L	1	160.2	04.14.01	B010106TSS	
ALINITY				1	310.1	04.15.01	I010020ALK	
Bicarbonate as CaCO3	50.	10.	mg/L					
Hydroxide as CaCO3	ND	10.	mg/L					
Carbonate as CaCO3	ND	10.	mg/L					
Total Alkalinity as CaCO3	50.	10.	mg/L					
Ammonia as N	ND	0.1	mg/L	1	350.2	04.18.01	I010047AMM	
Chloride	20.	2.	mg/L	2	300.0	05.02.01	I010059IC	
Phosphate as P, Total	ND	0.1	mg/L	1	365.2	04.15.01	I010033PHO	
Solids, Dissolved	100.	10.	mg/L	1	160.1	04.17.01	I010028TDS	
Solids, total	100.	10.	mg/L	1	160.3	04.16.01	I010005TS	
Sulfate	2.	1.	mg/L	2	300.0	05.02.01	I010059IC	
Total Kjeldahl Nitrogen	ND	0.1	mg/L	1	351.3	04.18.01	I010033TKN	
LAB NUMBER: B040329-11								
SAMPLE ID: EA-SP-B								
SAMPLED: 12 APR 01								
Mercury, Trace Level	4.0	0.5	ng/L	1	1631	05.01.01	A010415MER	3

1) Sample Preparation on 04-26-01 using 200.2 (Filtrate)
2) A "J" flagged result reflects a value seen below the Reporting Limit (RL), but above the Method Detection Limit (MDL).
3) Sample Preparation on 04-30-01 using 1631

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INORGANIC ANALYTICAL RESULTS

LAB NUMBER: B080597-8
SAMPLE ID: EA-SU-S
SAMPLED: 16 AUG 01 09:30

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
Mercury, Trace Level	0.0006	0.0005	ug/L	1	1631	09.07.01	A010863MER	1
Chemical Oxygen Demand	ND	50.	mg/L	1	410.4	08.28.01	B010242COD	
Solids, Suspended	ND	3.	mg/L	1	160.2	08.21.01	B010237TSS	
ALKALINITY				1	310.1	08.27.01	I010039ALK	
Bicarbonate as CaCO3	40.	10.	mg/L					
Hydroxide as CaCO3	ND	10.	mg/L					
Carbonate as CaCO3	20.	10.	mg/L					
Total Alkalinity as CaCO3	60.	10.	mg/L					
Ammonia as N	ND	0.1	mg/L	1	350.2	08.29.01	I010090AMM	
Chloride	14.	1.	mg/L	1	300.0	09.14.01	I010129IC	
Nitrate + Nitrite as N	ND	0.1	mg/L	1	353.2	01.13.01	I010034NNO	
Phosphate as P, Ortho	ND	0.1	mg/L	1	365.2	08.17.01	I010092PHO	2
Phosphate as P, Total	ND	0.1	mg/L	1	365.2	08.22.01	I010094PHO	
Solids, Dissolved	110.	10.	mg/L	1	160.1	08.23.01	I010059TDS	
Solids, Total	120.	10.	mg/L	1	160.3	08.25.01	I010018TS	
Sulfate	1.7	0.5	mg/L	1	300.0	09.14.01	I010129IC	
Total Kjeldahl Nitrogen	0.7	0.1	mg/L	1	351.3	08.28.01	I010065TKN	
Total Organic Carbon	6.	1.	mg/L	1	415.1	08.29.01	I010041TOC	

LAB NUMBER: B080597-9
SAMPLE ID: EA-SU-B
SAMPLED: 16 AUG 01 09:45

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
Arsenic, dissolved	ND	0.004	mg/L	1	200.7	08.23.01	A010805ICP	3
Cadmium, dissolved	ND	0.001	mg/L	1	200.7	08.23.01	A010805ICP	3
Calcium, dissolved	16.	0.5	mg/L	1	200.7	08.23.01	A010805ICP	3
Chromium, dissolved	ND	0.005	mg/L	1	200.7	08.23.01	A010805ICP	3
Copper, dissolved	ND	0.005	mg/L	1	200.7	08.23.01	A010805ICP	3
Iron, dissolved	0.08	0.05	mg/L	1	200.7	08.23.01	A010805ICP	3
Lead, dissolved	ND	0.003	mg/L	1	200.7	08.23.01	A010805ICP	3
Magnesium, dissolved	4.0	0.5	mg/L	1	200.7	08.23.01	A010805ICP	3
Manganese, dissolved	0.007	0.005	mg/L	1	200.7	08.23.01	A010805ICP	3
Mercury, Trace Level	0.035	0.0005	ug/L	1	1631	09.07.01	A010863MER	1
Potassium, dissolved	3.	1.	mg/L	1	200.7	08.23.01	A010805ICP	3
Selenium, dissolved	J0.003	0.01	mg/L	1	200.7	08.23.01	A010805ICP	3,4
Sodium, dissolved	14.	1.	mg/L	1	200.7	08.23.01	A010805ICP	3
Zinc, dissolved	ND	0.02	mg/L	1	200.7	08.23.01	A010805ICP	3

1) Sample Preparation on 09-06-01 using 1631
2) Sample filtered prior to analysis.
3) Sample Preparation on 08-22-01 using 200.2 (Filtrate)
4) A "J" flagged result reflects a value seen below the Reporting Limit (RL), but above the Method Detection Limit (MDL).

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INORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
LAB NUMBER: B080597-6 (continued)								
Calcium, dissolved	13.	0.5	mg/L	1	200.7	08.23.01	A010805ICP	1
Chromium, dissolved	ND	0.005	mg/L	1	200.7	08.23.01	A010805ICP	1
Copper, dissolved	ND	0.005	mg/L	1	200.7	08.23.01	A010805ICP	1
Iron, dissolved	ND	0.05	mg/L	1	200.7	08.23.01	A010805ICP	1
Lead, dissolved	ND	0.003	mg/L	1	200.7	08.23.01	A010805ICP	1
Magnesium, dissolved	2.8	0.5	mg/L	1	200.7	08.23.01	A010805ICP	1
Manganese, dissolved	J0.003	0.005	mg/L	1	200.7	08.23.01	A010805ICP	1,2
Mercury, Trace Level	J0.0003	0.0005	ug/L	1	1631	09.07.01	A010863MER	2,3
Potassium, dissolved	3.	1.	mg/L	1	200.7	08.23.01	A010805ICP	1
Selenium, dissolved	J0.002	0.01	mg/L	1	200.7	08.23.01	A010805ICP	1,2
Sodium, dissolved	13.	1.	mg/L	1	200.7	08.23.01	A010805ICP	1
Zinc, dissolved	ND	0.02	mg/L	1	200.7	08.23.01	A010805ICP	1

LAB NUMBER: B080597-7
SAMPLE ID: ES-SU-I
SAMPLED: 15 AUG 01 11:45

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
Arsenic, dissolved	ND	0.004	mg/L	1	200.7	08.23.01	A010805ICP	1
Cadmium, dissolved	ND	0.001	mg/L	1	200.7	08.23.01	A010805ICP	1
Calcium, dissolved	150.	1.	mg/L	2	200.7	08.27.01	A010805ICP	1
Chromium, dissolved	ND	0.005	mg/L	1	200.7	08.23.01	A010805ICP	1
Copper, dissolved	ND	0.005	mg/L	1	200.7	08.23.01	A010805ICP	1
Iron, dissolved	ND	0.05	mg/L	1	200.7	08.23.01	A010805ICP	1
Lead, dissolved	ND	0.003	mg/L	1	200.7	08.23.01	A010805ICP	1
Magnesium, dissolved	10.	0.5	mg/L	1	200.7	08.23.01	A010805ICP	1
Manganese, dissolved	0.14	0.005	mg/L	1	200.7	08.23.01	A010805ICP	1
Potassium, dissolved	10.	1.	mg/L	1	200.7	08.23.01	A010805ICP	1
Selenium, dissolved	J0.003	0.01	mg/L	1	200.7	08.23.01	A010805ICP	1,2
Sodium, dissolved	160.	1.	mg/L	1	200.7	08.23.01	A010805ICP	1
Zinc, dissolved	ND	0.02	mg/L	1	200.7	08.23.01	A010805ICP	1
Solids, Suspended	ND	3.	mg/L	1	160.2	08.21.01	B010237TSS	
ALKALINITY				1	310.1	08.27.01	I010039ALK	
Bicarbonate as CaCO3	100.	10.	mg/L					
Hydroxide as CaCO3	ND	10.	mg/L					
Carbonate as CaCO3	ND	10.	mg/L					
Total Alkalinity as CaCO3	100.	10.	mg/L					
Chloride	360.	25.	mg/L	25	300.0	09.14.01	I010129IC	
Solids, Dissolved	980.	20.	mg/L	2	160.1	08.22.01	I010058TDS	4
Solids, Total	1000.	10.	mg/L	1	160.3	08.25.01	I010018TS	
Sulfate	3.5	0.5	mg/L	1	300.0	09.14.01	I010129IC	

1) Sample Preparation on 08-22-01 using 200.2 (Filtrate)
2) A "J" flagged result reflects a value seen below the Reporting Limit (RL), but above the Method Detection Limit (MDL).
3) Sample Preparation on 09-06-01 using 1631
4) Sample data accepted based on blank and LCS

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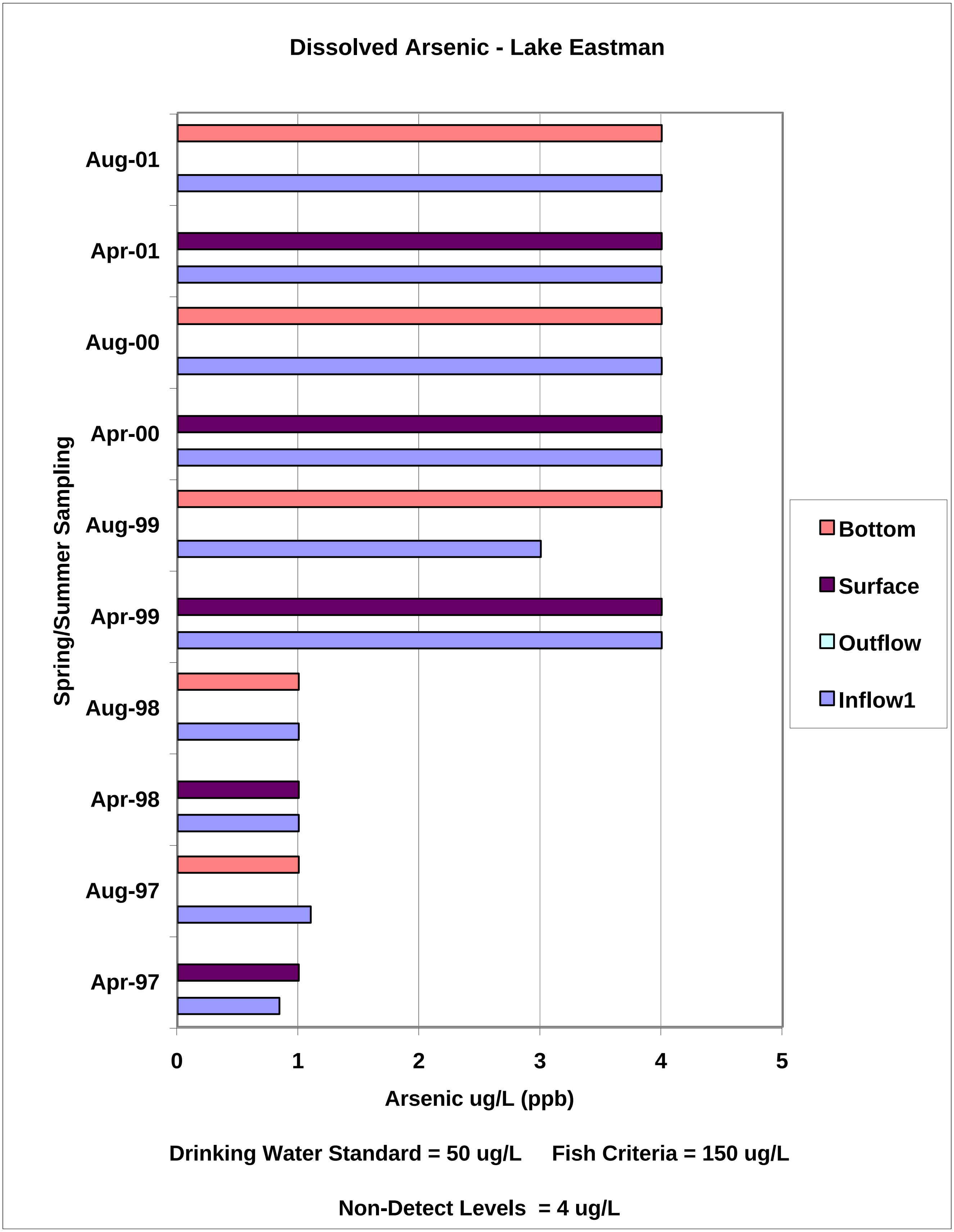
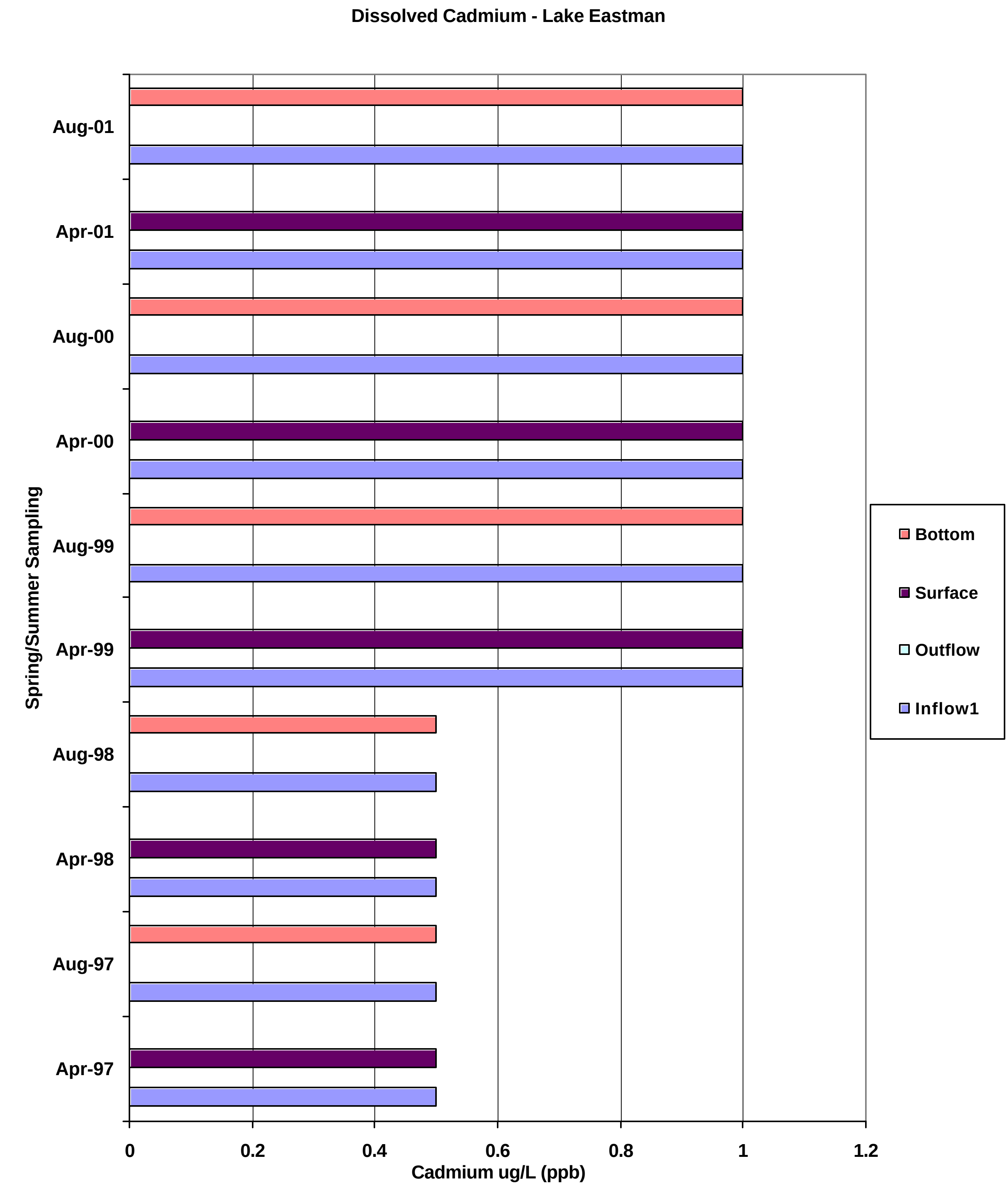
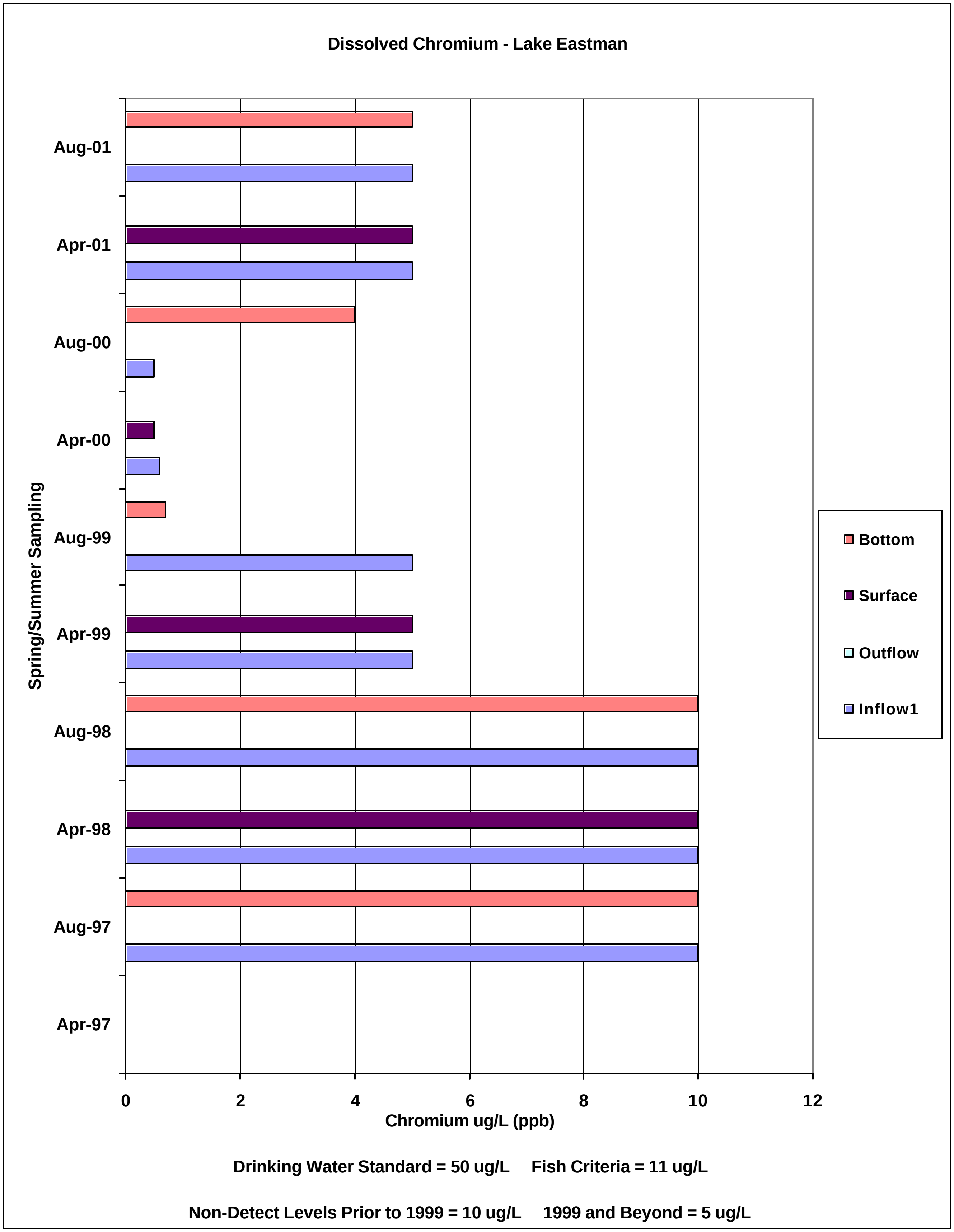
V Metals

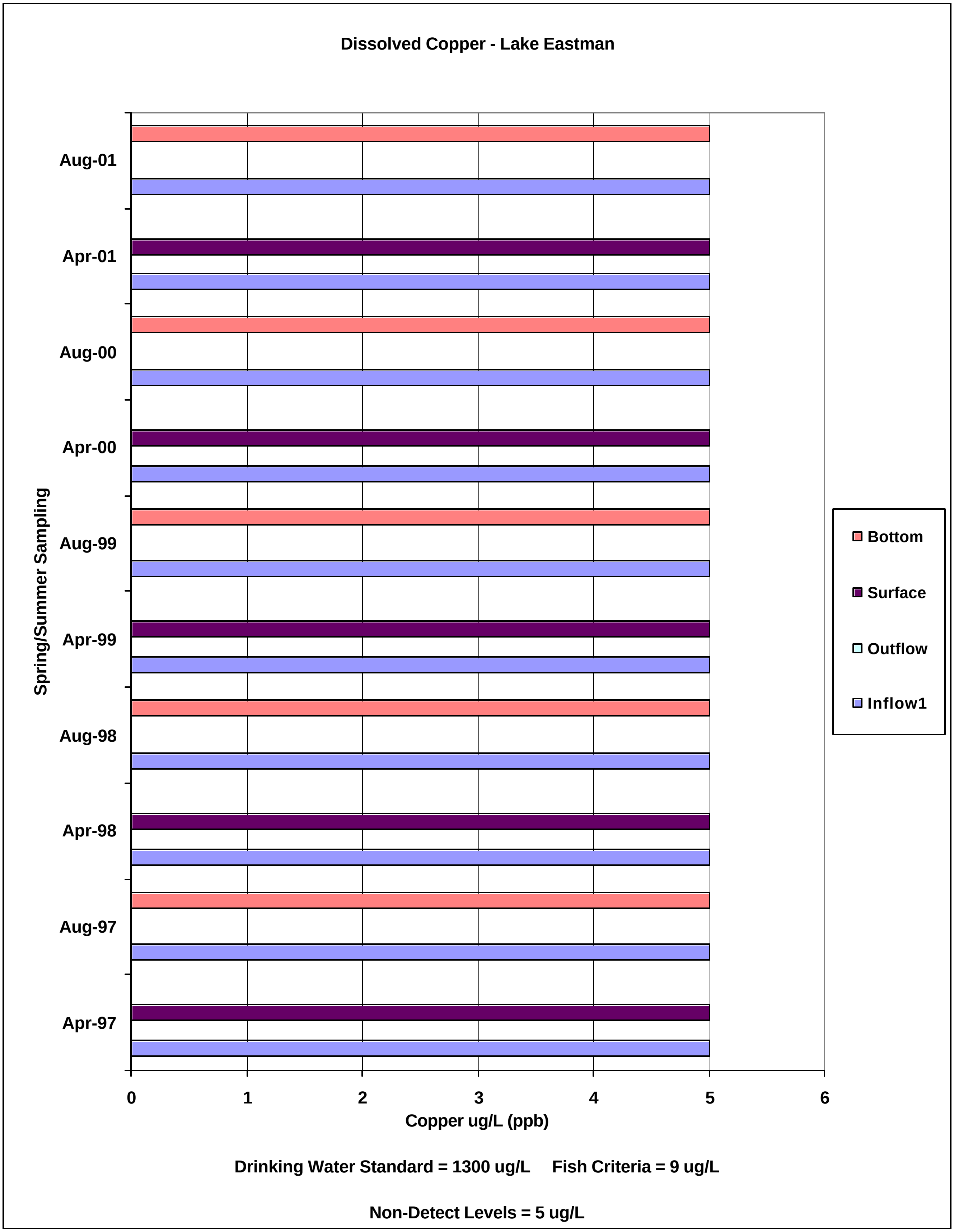

Dissolved Arsenic - Lake Eastman
Spring/Summer Sampling
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Aug-97
Apr-97
0
1
2
3
4
5
Arsenic ug/L (ppb)
Bottom
Surface
Outflow
Inflow1
Drinking Water Standard = 50 ug/L
Fish Criteria = 150 ug/L
Non-Detect Levels = 4 ug/L

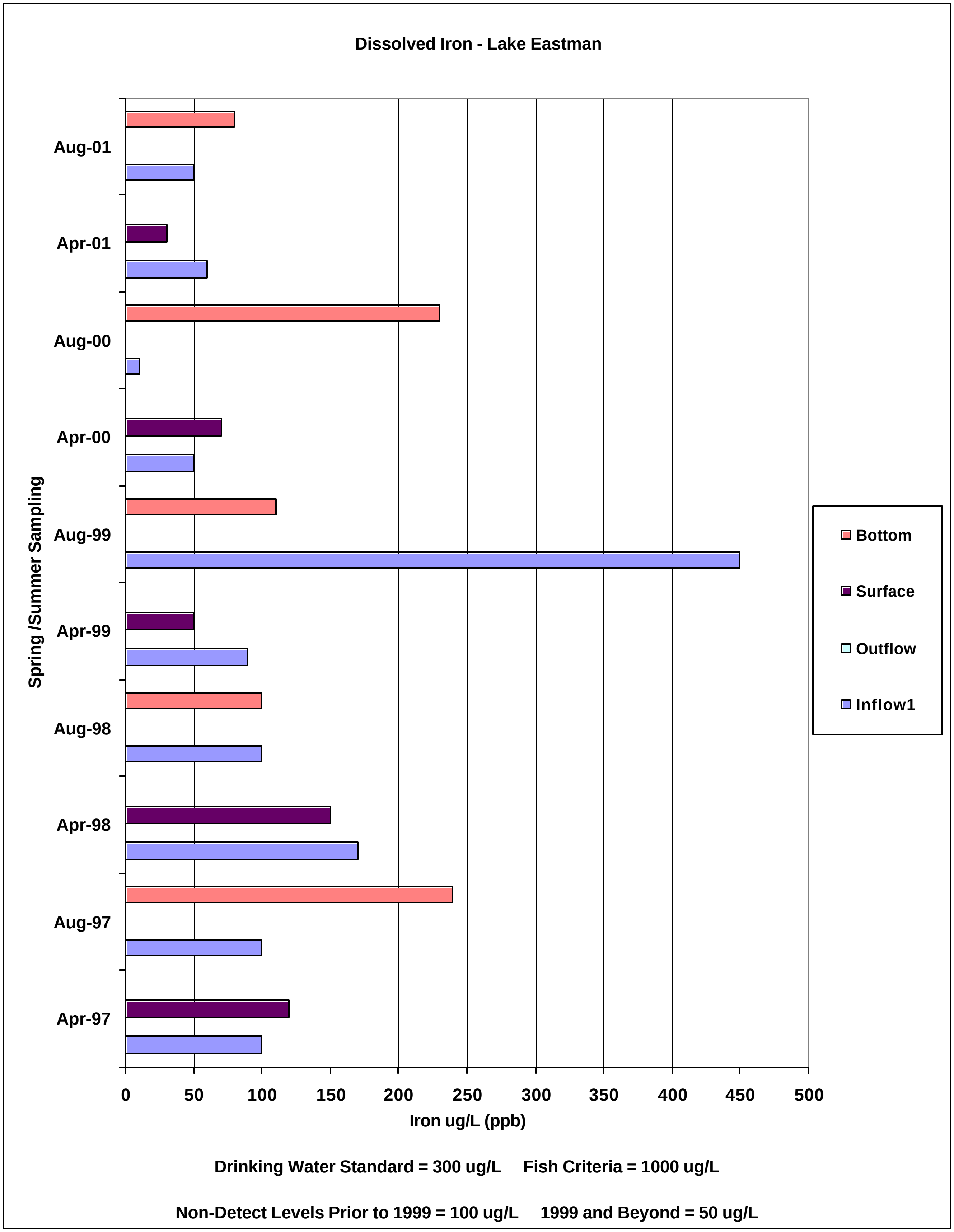


Drinking Water Standard = 5 ug/L   Fish Criteria = 2.2 ug/L

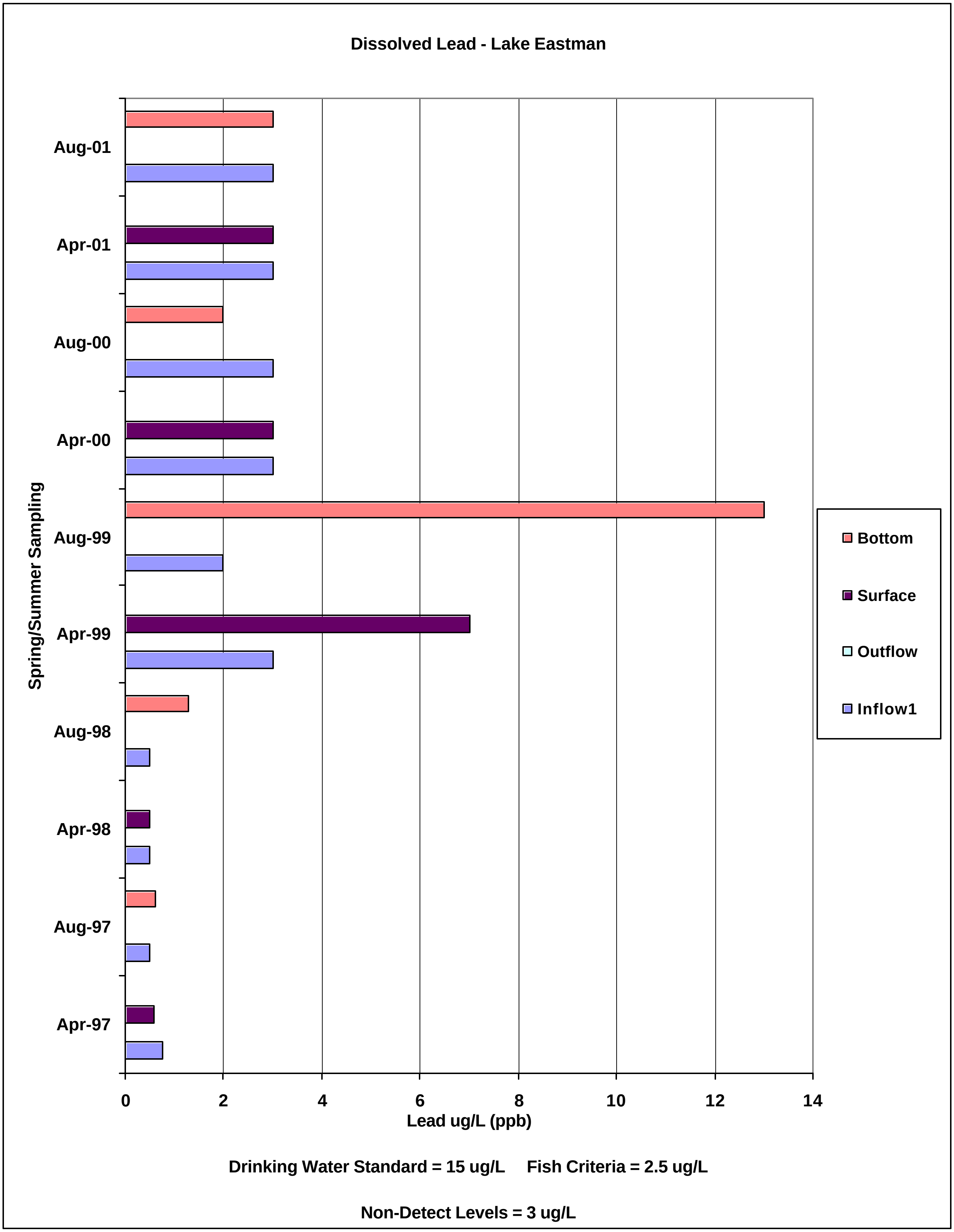
Non-Detect Levels Prior to 1999 = 0.5 ug/L   1999 and Beyond = 1 ug/L

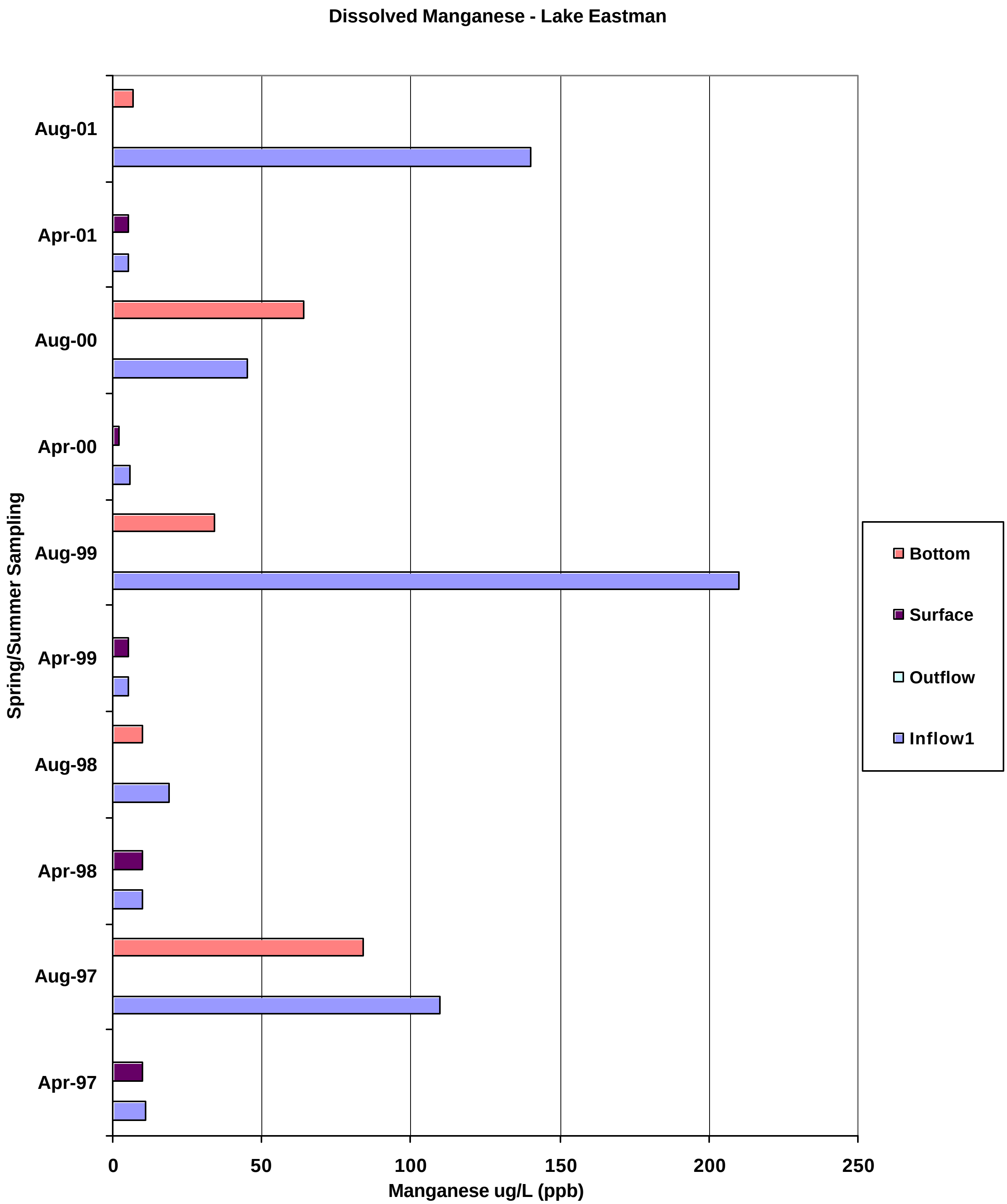

Dissolved Chromium - Lake Eastman
Spring/Summer Sampling
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Aug-97
Apr-97
0
2
4
6
8
10
12
Chromium ug/L (ppb)
Bottom
Surface
Outflow
Inflow1
Drinking Water Standard = 50 ug/L   Fish Criteria = 11 ug/L
Non-Detect Levels Prior to 1999 = 10 ug/L   1999 and Beyond = 5 ug/L


Dissolved Copper - Lake Eastman
Spring/Summer Sampling
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Aug-97
Apr-97
0
1
2
3
4
5
6
Copper ug/L (ppb)
Bottom
Surface
Outflow
Inflow1
Drinking Water Standard = 1300 ug/L
Fish Criteria = 9 ug/L
Non-Detect Levels = 5 ug/L



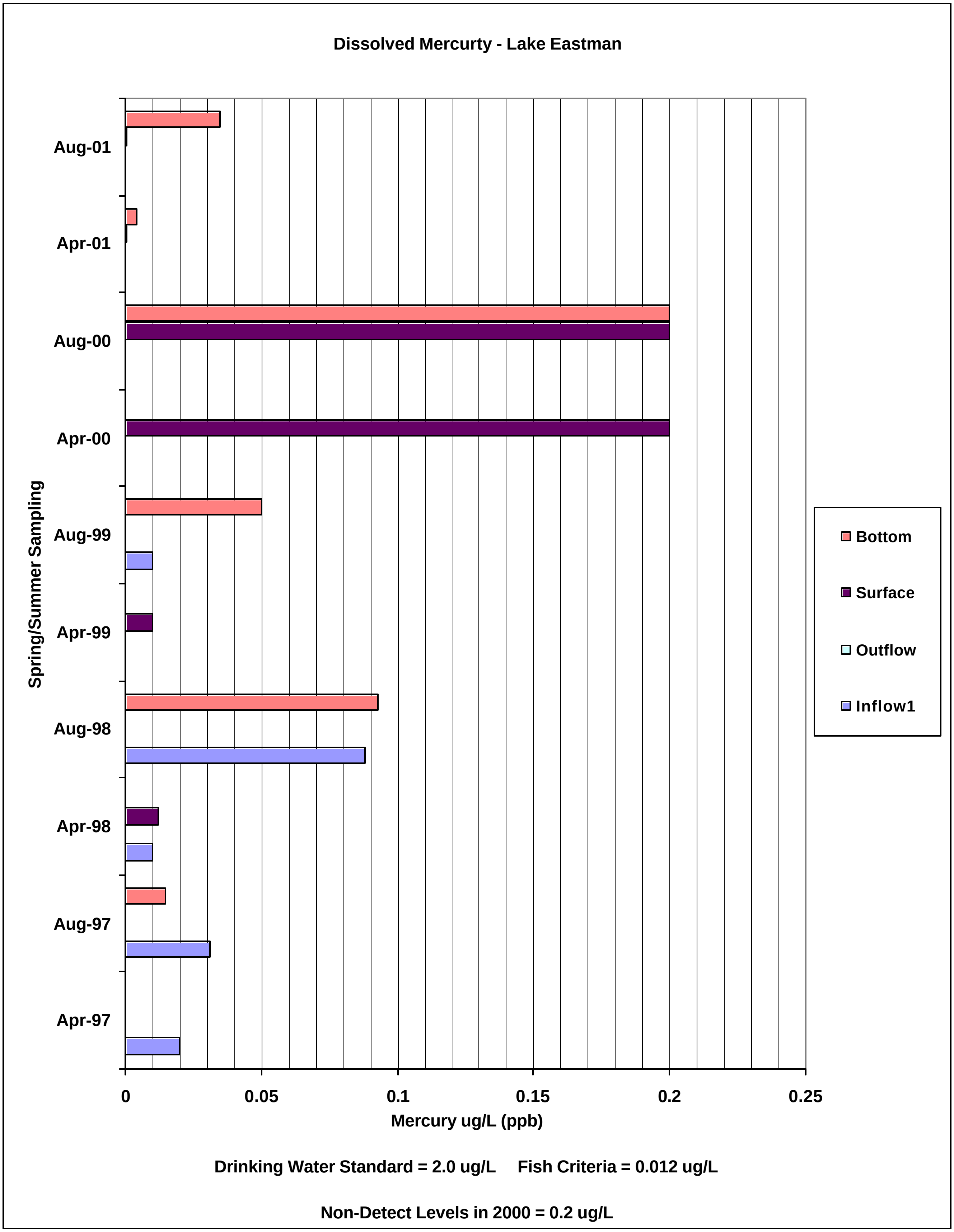
Dissolved Iron - Lake Eastman
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Aug-97
Apr-97
Spring /Summer Sampling
0
50
100
150
200
250
300
350
400
450
500
Iron ug/L (ppb)
Bottom
Surface
Outflow
Inflow1
Drinking Water Standard = 300 ug/L Fish Criteria = 1000 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L 1999 and Beyond = 50 ug/L

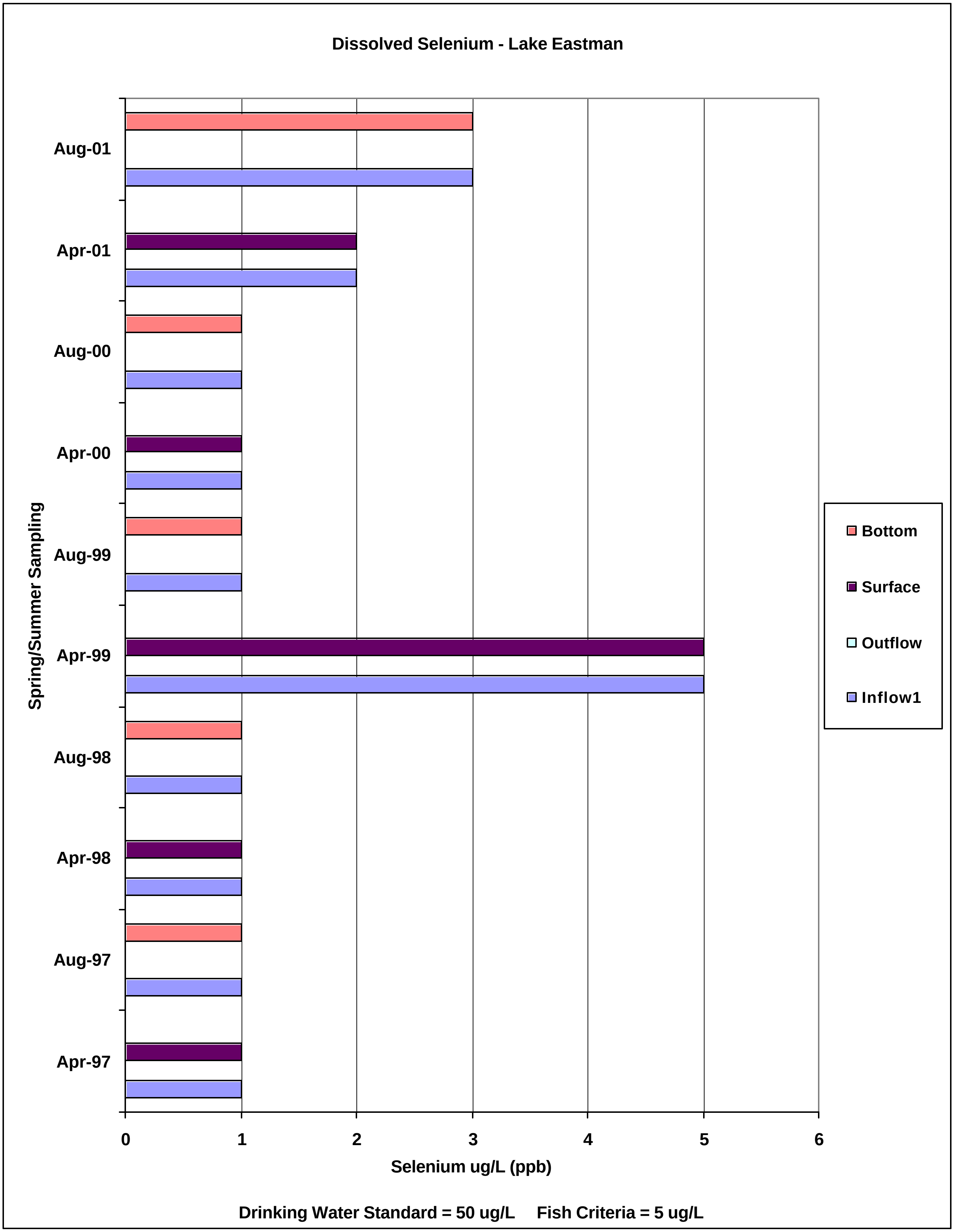

Dissolved Lead - Lake Eastman
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Aug-97
Apr-97
Spring/Summer Sampling
0
2
4
6
8
10
12
14
Lead ug/L (ppb)
Bottom
Surface
Outflow
Inflow1
Drinking Water Standard = 15 ug/L
Fish Criteria = 2.5 ug/L
Non-Detect Levels = 3 ug/L

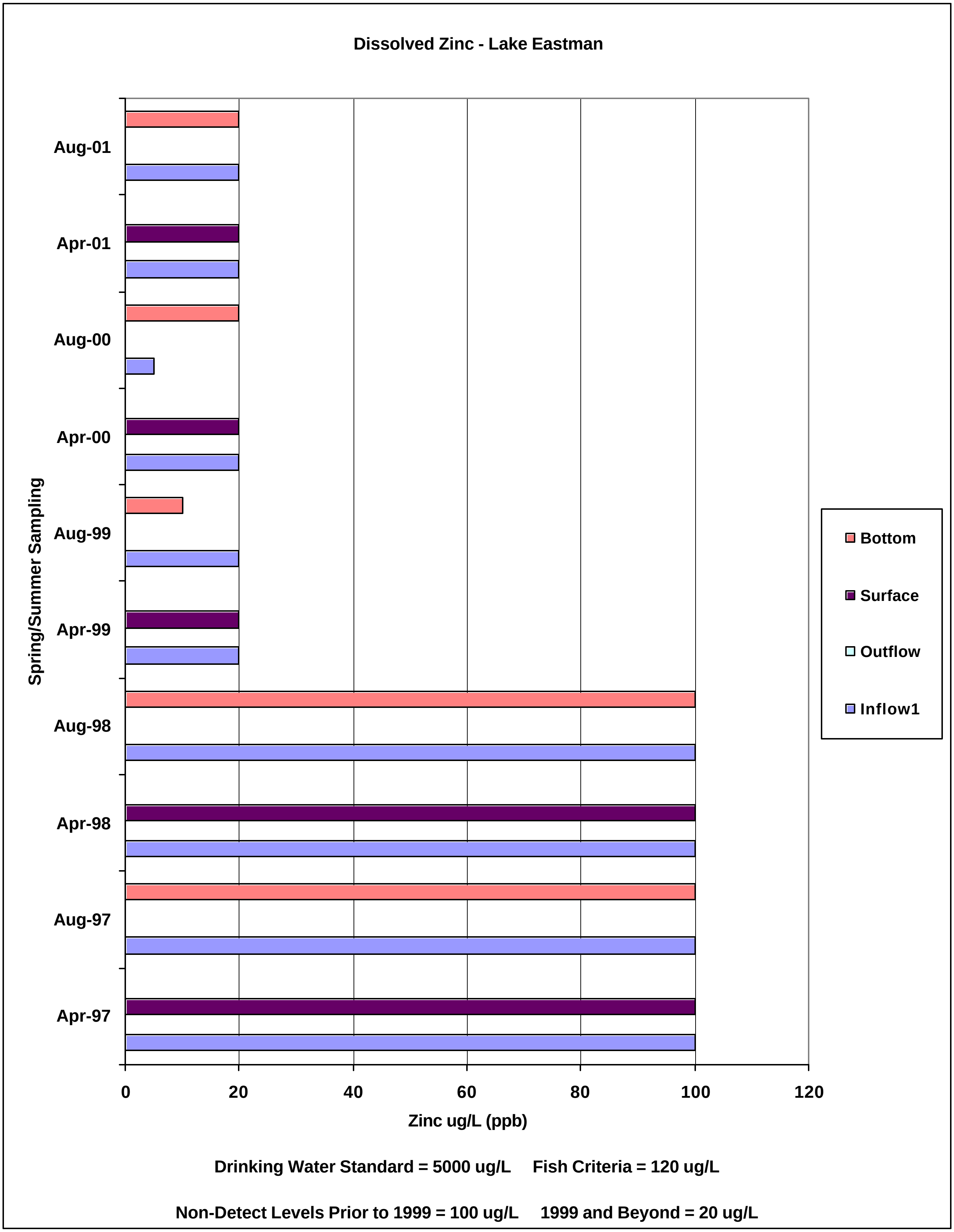


Drinking Water Standard = 50 ug/L Fish Criteria = none

Non-Detect Levels = 5 ug/L


Dissolved Mercurty - Lake Eastman
Spring/Summer Sampling
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Aug-97
Apr-97
0
0.05
0.1
0.15
0.2
0.25
Mercury ug/L (ppb)
Bottom
Surface
Outflow
Inflow1
Drinking Water Standard = 2.0 ug/L
Fish Criteria = 0.012 ug/L
Non-Detect Levels in 2000 = 0.2 ug/L


Dissolved Selenium - Lake Eastman
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Aug-97
Apr-97
Spring/Summer Sampling
0
1
2
3
4
5
6
Selenium ug/L (ppb)
Bottom
Surface
Outflow
Inflow1
Drinking Water Standard = 50 ug/L Fish Criteria = 5 ug/L


Dissolved Zinc - Lake Eastman
Aug-01
Apr-01
Aug-00
Apr-00
Aug-99
Apr-99
Aug-98
Apr-98
Aug-97
Apr-97
Spring/Summer Sampling
0
20
40
60
80
100
120
Zinc ug/L (ppb)
Bottom
Surface
Outflow
Inflow1
Drinking Water Standard = 5000 ug/L Fish Criteria = 120 ug/L
Non-Detect Levels Prior to 1999 = 100 ug/L 1999 and Beyond = 20 ug/L

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ANALYTICAL LABORATORY
ENVIRONMENTAL ANALYSES

INORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
LAB NUMBER: B040329-8 (continued)								
Solids, total	100.	10.	mg/L	1	160.3	04.16.01	I010005TS	
Sulfate	2.	1.	mg/L	2	300.0	05.02.01	I010059IC	
Total Kjeldahl Nitrogen	0.2	0.1	mg/L	1	351.3	04.18.01	I010033TKN	

LAB NUMBER: B040329-9
SAMPLE ID: EA-SP-I
SAMPLED: 11 APR 01

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
Arsenic, dissolved	ND	0.004	mg/L	1	200.7	04.26.01	A010396ICP	1
Cadmium, dissolved	ND	0.001	mg/L	1	200.7	04.26.01	A010396ICP	1
Calcium, dissolved	16.	0.5	mg/L	1	200.7	04.26.01	A010396ICP	1
Chromium, dissolved	ND	0.005	mg/L	1	200.7	04.26.01	A010396ICP	1
Copper, dissolved	ND	0.005	mg/L	1	200.7	04.26.01	A010396ICP	1
Iron, dissolved	0.06	0.05	mg/L	1	200.7	04.26.01	A010396ICP	1
Lead, dissolved	ND	0.003	mg/L	1	200.7	04.26.01	A010396ICP	1
Magnesium, dissolved	3.5	0.5	mg/L	1	200.7	04.26.01	A010396ICP	1
Manganese, dissolved	J0.005	0.005	mg/L	1	200.7	04.26.01	A010396ICP	1,2
Potassium, dissolved	2.	1.	mg/L	1	200.7	04.26.01	A010396ICP	1
Selenium, dissolved	J0.002	0.01	mg/L	1	200.7	04.26.01	A010396ICP	1,2
Sodium, dissolved	14.	1.	mg/L	1	200.7	04.26.01	A010396ICP	1
Zinc, dissolved	ND	0.02	mg/L	1	200.7	04.26.01	A010396ICP	1
Chemical Oxygen Demand	ND	50.	mg/L	1	410.4	04.16.01	B010110COD	
Solids, Suspended	ND	3.	mg/L	1	160.2	04.14.01	B010106TSS	
ALKALINITY				1	310.1	04.15.01	I010020ALK	
Bicarbonate as CaCO3	50.	10.	mg/L					
Hydroxide as CaCO3	ND	10.	mg/L					
Carbonate as CaCO3	ND	10.	mg/L					
Total Alkalinity as CaCO3	50.	10.	mg/L					
Ammonia as N	ND	0.1	mg/L	1	350.2	04.17.01	I010046AMM	
Chloride	15.	1.	mg/L	1	SM4500	05.15.01	I010001CHL	
Nitrate + Nitrite as N	ND	0.1	mg/L	1	353.2	05.08.01	I010021NNO	3
Phosphate as P, Total	ND	0.1	mg/L	1	365.2	04.15.01	I010033PHO	
Solids, Dissolved	140.	10.	mg/L	1	160.1	04.17.01	I010028TDS	
Solids, total	120.	10.	mg/L	1	160.3	04.16.01	I010005TS	
Sulfate	J0.9	1.	mg/L	2	300.0	05.09.01	I010062IC	2
Total Kjeldahl Nitrogen	0.2	0.1	mg/L	1	351.3	04.18.01	I010033TKN	

1) Sample Preparation on 04-26-01 using 200.2 (Filtrate)
2) A "J" flagged result reflects a value seen below the Reporting Limit (RL), but above the Method Detection Limit (MDL).
3) Sample Preparation on 04-30-01

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INORGANIC ANALYTICAL RESULTS

LAB NUMBER: B040329-10
SAMPLE ID: EA-SP-S
SAMPLED: 12 APR 01

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
Arsenic, dissolved	ND	0.004	mg/L	1	200.7	04.26.01	A010396ICP	1
Cadmium, dissolved	ND	0.001	mg/L	1	200.7	04.26.01	A010396ICP	1
Calcium, dissolved	14.	0.5	mg/L	1	200.7	04.26.01	A010396ICP	1
Chromium, dissolved	ND	0.005	mg/L	1	200.7	04.26.01	A010396ICP	1
Copper, dissolved	ND	0.005	mg/L	1	200.7	04.26.01	A010396ICP	1
Iron, dissolved	J0.03	0.05	mg/L	1	200.7	04.26.01	A010396ICP	1,2
Lead, dissolved	ND	0.003	mg/L	1	200.7	04.26.01	A010396ICP	1
Magnesium, dissolved	3.5	0.5	mg/L	1	200.7	04.26.01	A010396ICP	1
Manganese, dissolved	J0.005	0.005	mg/L	1	200.7	04.26.01	A010396ICP	1,2
Mercury, Trace Level	0.6	0.5	ng/L	1	1631	05.01.01	A010415MER	3
Potassium, dissolved	3.	1.	mg/L	1	200.7	04.26.01	A010396ICP	1
Selenium, dissolved	J0.002	0.01	mg/L	1	200.7	04.26.01	A010396ICP	1,2
Sodium, dissolved	11.	1.	mg/L	1	200.7	04.26.01	A010396ICP	1
Zinc, dissolved	ND	0.02	mg/L	1	200.7	04.26.01	A010396ICP	1
Chemical Oxygen Demand	ND	50.	mg/L	1	410.4	04.16.01	B010110COD	
Solids, Suspended	ND	3.	mg/L	1	160.2	04.14.01	B010106TSS	
ALKALINITY				1	310.1	04.15.01	I010020ALK	
Bicarbonate as CaCO3	50.	10.	mg/L					
Hydroxide as CaCO3	ND	10.	mg/L					
Carbonate as CaCO3	ND	10.	mg/L					
Total Alkalinity as CaCO3	50.	10.	mg/L					
Ammonia as N	ND	0.1	mg/L	1	350.2	04.18.01	I010047AMM	
Chloride	20.	2.	mg/L	2	300.0	05.02.01	I010059IC	
Phosphate as P, Total	ND	0.1	mg/L	1	365.2	04.15.01	I010033PHO	
Solids, Dissolved	100.	10.	mg/L	1	160.1	04.17.01	I010028TDS	
Solids, total	100.	10.	mg/L	1	160.3	04.16.01	I010005TS	
Sulfate	2.	1.	mg/L	2	300.0	05.02.01	I010059IC	
Total Kjeldahl Nitrogen	ND	0.1	mg/L	1	351.3	04.18.01	I010033TKN	

LAB NUMBER: B040329-11
SAMPLE ID: EA-SP-B
SAMPLED: 12 APR 01

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
Mercury, Trace Level	4.0	0.5	ng/L	1	1631	05.01.01	A010415MER	3

1) Sample Preparation on 04-26-01 using 200.2 (Filtrate)
2) A "J" flagged result reflects a value seen below the Reporting Limit (RL), but above the Method Detection Limit (MDL).
3) Sample Preparation on 04-30-01 using 1631

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LAB ORDER No.: B080597

INORGANIC ANALYTICAL RESULTS

LAB NUMBER: B080597-8
SAMPLE ID: EA-SU-S
SAMPLED: 16 AUG 01 09:30

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
Mercury, Trace Level	0.0006	0.0005	ug/L	1	1631	09.07.01	A010863MER	1
Chemical Oxygen Demand	ND	50.	mg/L	1	410.4	08.28.01	B010242COD	
Solids, Suspended	ND	3.	mg/L	1	160.2	08.21.01	B010237TSS	
ALKALINITY				1	310.1	08.27.01	I010039ALK	
Bicarbonate as CaCO3	40.	10.	mg/L					
Hydroxide as CaCO3	ND	10.	mg/L					
Carbonate as CaCO3	20.	10.	mg/L					
Total Alkalinity as CaCO3	60.	10.	mg/L					
Ammonia as N	ND	0.1	mg/L	1	350.2	08.29.01	I010090AMM	
Chloride	14.	1.	mg/L	1	300.0	09.14.01	I010129IC	
Nitrate + Nitrite as N	ND	0.1	mg/L	1	353.2	01.13.01	I010034NNO	
Phosphate as P, Ortho	ND	0.1	mg/L	1	365.2	08.17.01	I010092PHO	2
Phosphate as P, Total	ND	0.1	mg/L	1	365.2	08.22.01	I010094PHO	
Solids, Dissolved	110.	10.	mg/L	1	160.1	08.23.01	I010059TDS	
Solids, Total	120.	10.	mg/L	1	160.3	08.25.01	I010018TS	
Sulfate	1.7	0.5	mg/L	1	300.0	09.14.01	I010129IC	
tal Kjeldahl Nitrogen	0.7	0.1	mg/L	1	351.3	08.28.01	I010065TKN	
Total Organic Carbon	6.	1.	mg/L	1	415.1	08.29.01	I010041TOC	

LAB NUMBER: B080597-9
SAMPLE ID: EA-SU-B
SAMPLED: 16 AUG 01 09:45

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
Arsenic, dissolved	ND	0.004	mg/L	1	200.7	08.23.01	A010805ICP	3
Cadmium, dissolved	ND	0.001	mg/L	1	200.7	08.23.01	A010805ICP	3
Calcium, dissolved	16.	0.5	mg/L	1	200.7	08.23.01	A010805ICP	3
Chromium, dissolved	ND	0.005	mg/L	1	200.7	08.23.01	A010805ICP	3
Copper, dissolved	ND	0.005	mg/L	1	200.7	08.23.01	A010805ICP	3
Iron, dissolved	0.08	0.05	mg/L	1	200.7	08.23.01	A010805ICP	3
Lead, dissolved	ND	0.003	mg/L	1	200.7	08.23.01	A010805ICP	3
Magnesium, dissolved	4.0	0.5	mg/L	1	200.7	08.23.01	A010805ICP	3
Manganese, dissolved	0.007	0.005	mg/L	1	200.7	08.23.01	A010805ICP	3
Mercury, Trace Level	0.035	0.0005	ug/L	1	1631	09.07.01	A010863MER	1
Potassium, dissolved	3.	1.	mg/L	1	200.7	08.23.01	A010805ICP	3
Selenium, dissolved	J0.003	0.01	mg/L	1	200.7	08.23.01	A010805ICP	3,4
Sodium, dissolved	14.	1.	mg/L	1	200.7	08.23.01	A010805ICP	3
Zinc, dissolved	ND	0.02	mg/L	1	200.7	08.23.01	A010805ICP	3

1) Sample Preparation on 09-06-01 using 1631
2) Sample filtered prior to analysis.
3) Sample Preparation on 08-22-01 using 200.2 (Filtrate)
4) A "J" flagged result reflects a value seen below the Reporting Limit (RL), but above the Method Detection Limit (MDL).

Caltest
ANALYTICAL LABORATORY
ENVIRONMENTAL ANALYSES

INORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
LAB NUMBER: B080597-6 (continued)								
Calcium, dissolved	13.	0.5	mg/L	1	200.7	08.23.01	A010805ICP	1
Chromium, dissolved	ND	0.005	mg/L	1	200.7	08.23.01	A010805ICP	1
Copper, dissolved	ND	0.005	mg/L	1	200.7	08.23.01	A010805ICP	1
Iron, dissolved	ND	0.05	mg/L	1	200.7	08.23.01	A010805ICP	1
Lead, dissolved	ND	0.003	mg/L	1	200.7	08.23.01	A010805ICP	1
Magnesium, dissolved	2.8	0.5	mg/L	1	200.7	08.23.01	A010805ICP	1
Manganese, dissolved	J0.003	0.005	mg/L	1	200.7	08.23.01	A010805ICP	1,2
Mercury, Trace Level	J0.0003	0.0005	ug/L	1	1631	09.07.01	A010863MER	2,3
Potassium, dissolved	3.	1.	mg/L	1	200.7	08.23.01	A010805ICP	1
Selenium, dissolved	J0.002	0.01	mg/L	1	200.7	08.23.01	A010805ICP	1,2
Sodium, dissolved	13.	1.	mg/L	1	200.7	08.23.01	A010805ICP	1
Zinc, dissolved	ND	0.02	mg/L	1	200.7	08.23.01	A010805ICP	1

LAB NUMBER: B080597-7
SAMPLE ID: ES-SU-I
SAMPLED: 15 AUG 01 11:45

ANALYTE	RESULT	R.L.	UNITS	D.F.	METHOD	ANALYZED	QC BATCH	NOTES
senic, dissolved	ND	0.004	mg/L	1	200.7	08.23.01	A010805ICP	1
admium, dissolved	ND	0.001	mg/L	1	200.7	08.23.01	A010805ICP	1
Calcium, dissolved	150.	1.	mg/L	2	200.7	08.27.01	A010805ICP	1
Chromium, dissolved	ND	0.005	mg/L	1	200.7	08.23.01	A010805ICP	1
Copper, dissolved	ND	0.005	mg/L	1	200.7	08.23.01	A010805ICP	1
Iron, dissolved	ND	0.05	mg/L	1	200.7	08.23.01	A010805ICP	1
Lead, dissolved	ND	0.003	mg/L	1	200.7	08.23.01	A010805ICP	1
Magnesium, dissolved	10.	0.5	mg/L	1	200.7	08.23.01	A010805ICP	1
Manganese, dissolved	0.14	0.005	mg/L	1	200.7	08.23.01	A010805ICP	1
Potassium, dissolved	10.	1.	mg/L	1	200.7	08.23.01	A010805ICP	1
Selenium, dissolved	J0.003	0.01	mg/L	1	200.7	08.23.01	A010805ICP	1,2
Sodium, dissolved	160.	1.	mg/L	1	200.7	08.23.01	A010805ICP	1
Zinc, dissolved	ND	0.02	mg/L	1	200.7	08.23.01	A010805ICP	1
Solids, Suspended	ND	3.	mg/L	1	160.2	08.21.01	B010237TSS	
ALKALINITY				1	310.1	08.27.01	I010039ALK	
Bicarbonate as CaCO3	100.	10.	mg/L					
Hydroxide as CaCO3	ND	10.	mg/L					
Carbonate as CaCO3	ND	10.	mg/L					
Total Alkalinity as CaCO3	100.	10.	mg/L					
Chloride	360.	25.	mg/L	25	300.0	09.14.01	I010129IC	
Solids, Dissolved	980.	20.	mg/L	2	160.1	08.22.01	I010058TDS	4
Solids, Total	1000.	10.	mg/L	1	160.3	08.25.01	I010018TS	
Sulfate	3.5	0.5	mg/L	1	300.0	09.14.01	I010129IC	

1) Sample Preparation on 08-22-01 using 200.2 (Filtrate)
2) A "J" flagged result reflects a value seen below the Reporting Limit (RL), but above the Method Detection Limit (MDL).
3) Sample Preparation on 09-06-01 using 1631
4) Sample data accepted based on blank and LCS

VI Fish Tissue

2001 Fish Tissue Results

The following table provides an overview of the lab results for the 2001 fish tissue program. N/A indicates data is not available due to lack of fish collection. Sample Preparation, filleting and Extraction were in accordance with EPA 823-R-95-007, Sep 95, Volume 1, Section 7.2 (Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisory) which requires the following: Only the edible portion of the fillet shall be analyzed (i.e no skin, tail, fin, head). Tissue digestion shall be accomplished by adding concentrated nitric acid and heating the tube in an aluminum block to reflux the acid. The digestate shall be cooled, diluted to a final volume of 25 ml and analyzed by CVAA. The laboratory conductng the preparation and analysis was Toxscan, Inc in Watsonville, CA and the laboratory mercury analysis was in accordance with CVAA per EPA 7471. The Percent Lipids were per EPA 1664. The FDA criteria for a fish advisory is 1 ppm. The EPA's action level to continue fish tissue monitoring is 0.3 ppm.

Lake	Type of Fish	Type of Analysis (number of fish)	Date collected	Percent Lipids	Total Mercury	FDA Criteria
Black Butte	Lg M Bass	Composite (3)	8/29/01	0.12	0.58	1 ppm
Eastman	Note 4	-	-	-	-	1 ppm
Englebright	Sm M Bass	Composite (2)	8/4/01	0.12	0.25	1 ppm
Hensley	Sm M Bass	Composite (2)	1/30/02	0.079	0.30	1 ppm
Isabella	Note 5	-	-	-	-	1 ppm
Kaweah	Blk Bass	Composite (3)	9/28/01	0.76	0.40	1 ppm
Martis Cr	Note 4	-	-	-	-	-
Mendocino	Lg M Bass	Composite (3)	9/25/01	1.4	0.34	1 ppm
New Hogan	Lg M Bass	Composite (3)	8/14/01	0.75	0.60	1 ppm
Pine Flat	Spotted Bass	Composite (3)	7/08/01	0.53	0.23	1 ppm
Sonoma	Lg M Bass	Composite (3)	11/08/01	0.058	0.43	1 ppm
Success	Blk Bass	Composite (3)	9/10/01	0.44	0.29	1 ppm

Notes:

1. Non-Detect is indicated by "<0.02" since the lab Detection Limit is 0.02 ppm.

2. Total Mercury was reported in mg/L or ppm.

3. Total Mercury was conducted instead of Methyl Mercury since EPA 832 allows Total Mercury analysis for an initial screening program. When specific problem areas are identified, methyl mercury analysis are normally performed later as part of the actual health risk assessment.

4. The fish tissue program was terminated at Eastman and Martis Creek in 2001 due to low total mercury results in 2000. In 2000, the total mercury was only 0.089 ppm for Eastman (Catfish) and the total mercury was <0.02 ppm for Martis Creek (Brown Trout).

5. Due to seasonal conditions, a fish could not be successfully collected at Lake Isabella. Another attempt will be accomplished for the 2002 report.

The above 2001 total mercury results indicate only New Hogan and Black Butte are relatively higher than average. However, in 2000, the total mercury results were only 0.52 ppm for New Hogan (catfish) and only 0.37 ppm for Black Butte (catfish). The 2002 fish tissue program should provide additional data. The attached EPA fact sheet on fish advisory indicates that the mean average mercury results from numerous lakes in the Northeast United States were found to be 0.46-0.51 ppm for largemouth bass and 0.34-0.53 for smallmouth bass.

EPA United States Environmental Protection Agency
Office of Water

FACT SHEET

United States Environmental Protection Agency | Office of Water 4305 | EPA-823-F-99-016 September 1999

Mercury Update: Impact on Fish Advisories

Summary

Mercury is distributed throughout the environment from both natural sources and human activities. Methylmercury is the main form of organic mercury found in the environment and is the form that accumulates in both fish and human tissues. Three major episodes of methylmercury poisoning through consumption of contaminated food have occurred; these resulted in central nervous system effects such as impairment of peripheral vision, mental symptoms, loss of feeling, and, at high doses, seizures, very severe neurological impairment, and death. Methylmercury has also been shown to be a developmental toxicant, causing subtle to severe neurological effects. EPA considers there is sufficient evidence for methylmercury to be considered a developmental toxicant, to be of concern for potential human mutagenicity, and to be a possible human carcinogen (Group C). As of December 1998, 40 states have issued 1,931 fish advisories for mercury. These advisories inform the public that concentrations of mercury have been found in local fish at levels of public health concern. State advisories recommend either limiting or avoiding consumption of certain fish from specific waterbodies or, in some cases, from specific waterbody types (e.g., all freshwater lakes or rivers).

> The purpose of this fact sheet is to summarize current information on sources, fate and transport, occurrence in human tissues, range of concentrations in fish tissue, fish advisories, fish consumption limits, toxicity, and regulations for mercury. The fact sheets also illustrate how this information may be used for developing fish consumption advisories. An electronic version of this fact sheet and fact sheets for dioxins/furans, PCBs, and toxaphene are available at http://www.epa.gov/OST/fish. Future revisions will be posted on the web as they become available.

Sources of Mercury in the Environment

Mercury is found in the environment in the metallic form and in different inorganic and organic forms. Most of the mercury in the atmosphere is elemental mercury vapor; most of the mercury in water, soil, plants, and animals is inorganic and organic mercury (primarily methylmercury).

Mercury occurs naturally and is distributed throughout the environment by both natural processes and human activities. Solid waste incineration and fossil fuel combustion facilities contribute approximately 87% of the emissions of mercury in the United States. Other sources of mercury releases to the air include mining and smelting, industrial processes involving the use of mercury such as chlor-alkali production facilities and production of cement.

Mercury is released to surface waters from naturally occurring mercury in rocks and soils and from industrial activities, including pulp and paper mills, leather tanning, electroplating, and chemical manufacturing. Wastewater treatment facilities may also release mercury to water. An indirect source of mercury to surface waters is mercury in the air; it is deposited from rain and other processes directly to water surfaces and to soils. Mercury also may be mobilized from sediments if disturbed (e.g., flooding, dredging).

Sources of mercury in soil include direct application of fertilizers and fungicides and disposal of solid waste, including batteries and thermometers, to landfills. The disposal of municipal incinerator ash in landfills and the application of sewage sludge to crop land result in increased levels of mercury in soil. Mercury in air may also be deposited in soil and sediments.

Fate and Transport of Mercury

The global cycling of mercury is a complex process. Mercury evaporates from soils and surface waters to the atmosphere, is redeposited on land and surface water, and then is absorbed by soil or sediments. After redeposition on land and water, mercury is commonly volatilized back to the atmosphere as a gas or as adherents to particulates.

Mercury exists in a number of inorganic and organic forms in water. Methylmercury, the most common organic form of mercury, quickly enters the aquatic food chain. In most adult fish, 90% to 100% of the mercury is methylmercury. Methylmercury is found primarily in the fish muscle (fillets) bound to proteins.

Skinning and trimming the fish does not significantly reduce the mercury concentration in the fillet, nor is it removed by cooking processes. Because moisture is lost during cooking, the concentration of mercury after cooking is actually higher than it is in the fresh uncooked fish.

Concentrations of total mercury in fish at the top of the food chain, such as pike, shark, and swordfish, are approximately 10,000 to 100,000 times higher than the concentrations of inorganic mercury found in the surrounding waters. The bioconcentration factor (BCF) of methylmercury in fish is on the order of 3 million. The bioaccumulation of methylmercury is even greater. Methylmercury levels in predator fish are, on average, approximately 7 million times higher than the concentrations of dissolved methylmercury found in the surrounding waters.

In 1984 and 1985, the U.S. Fish and Wildlife Service collected 315 composite samples of whole fish from 109 stations nationwide as part of the National Contaminant Biomonitoring Program (NCBP). The maximum, geometric mean, and 85th percentile concentrations for mercury were 0.37, 0.10, and 0.17 ppm (wet weight), respectively. An analysis of mercury levels in tissues of bottom-feeding and predatory fish using the data from the NCBP study showed that the mean mercury tissue concentration of 0.12 ± 0.08 ppm in predatory fish species (e.g., trout, walleye, largemouth bass) was significantly higher than the mean tissue concentration of 0.08 ± 0.06 ppm in bottom feeders (e.g., carp, white sucker, and channel catfish).

Mercury, the only metal analyzed as part of EPA's 1987 National Study of Chemical Residues in Fish (NSCRF), was detected at 92% of 374 sites surveyed. Maximum, arithmetic mean, and median concentrations in fish tissue were 1.77, 0.26, and 0.17 ppm (wet weight), respectively. Mean mercury concentrations in bottom feeders (whole body samples) were generally lower than concentrations for predator fish (fillet samples) (see Table 1). Most of the higher tissue concentrations of mercury were detected in freshwater fish samples collected in the Northeast.

Most recently, the northeast states and eastern Canadian provinces issued their own mercury study, including a comprehensive analysis of mercury concentrations in a variety of freshwater sportfish collected from the late 1980s to 1996. Top level predatory fish such as walleye, chain pickerel, and large and smallmouth bass were typically found to exhibit the highest concentrations, with mean tissue residues greater than 0.5 ppm and maximum residues exceeding 2 ppm. One largemouth bass sample was found to contain 8.94 ppm of mercury, while a smallmouth bass sampled contained 5 ppm. Table 2 summarizes the range and the mean concentrations found in eight species of sportfish sampled.

Mercury has also been detected in marine fish species. Concentrations of methylmercury in muscle tissue in nine species of Atlantic shark averaged 0.88 µg/g (ppm) (wet weight) and ranged from 0.06 to 2.87 µg/g (ppm). Bluefin tuna from the northwest Atlantic Ocean contained mercury at a mean muscle concentration of 3.41 µg/g (ppm)(dry weight).

Table 1. Mean Mercury Concentration in Freshwater Fish*

Species	Mean concentration (ppm)**
Bottom Feeders	
Carp	0.11
White sucker	0.11
Channel catfish	0.09
Predator Fish	
Largemouth bass	0.46
Smallmouth bass	0.34
Walleye	0.52
Brown trout	0.14

*EPA National Study of Chemical Residues in Fish conducted in 1987; species included freshwater, estuarine, and marine finfish; and a small number of marine shellfish.
**Concentration are reported on wet weight basis
Source: Bahnick et al., 1994

Table 2. Mercury Concentration for Selected Fish Species in the Northeast

Species	Mean concentration* (ppm)	Minimum-maximum range* (ppm)
Largemouth bass	0.51	0-8.94
Smallmouth bass	0.53	0.08-5.0
Yellow perch	0.40	0-3.15
Eastern chain pickerel	0.64	0-2.81
Lake trout	0.32	0-2.70
Walleye	0.77	0.10-2.04
Brown bullhead	0.20	0-1.10
Brook trout	0.26	0-0.98

*Concentration are reported on a wet weight basis.
Source: NESCAUM, 1998.

Because of the higher cost of methylmercury analysis, EPA recommends that total mercury rather than methylmercury concentrations be determined in state fish contaminant monitoring programs. EPA also recommends that the conservative assumption be made that all mercury is present as methylmercury in order to be most protective of human health.

Potential Sources of Exposure and Occurrence in Human Tissues

Potential sources of human exposure to mercury include food contaminated with mercury, inhalation of mercury vapors in ambient air, and exposure to mercury through dental and medical treatments. Dietary intake is by far the most important source of exposure to mercury for the general population. Fish and other seafood products are the main source of methylmercury in the diet; studies have shown that methylmercury concentrations in fish and shellfish are approximately 10 to 100 times greater than in other foods, including cereals, potatoes, vegetables, fruits, meats, poultry, eggs, and milk.

Individuals who may be exposed to higher than average levels of methylmercury include recreational and subsistence fishers who routinely consume large amounts of locally caught fish and subsistence hunters who routinely consume the meat and organ tissues of marine mammals.

Analytical methods are available to measure mercury in blood, urine, tissue, hair, and breast milk.

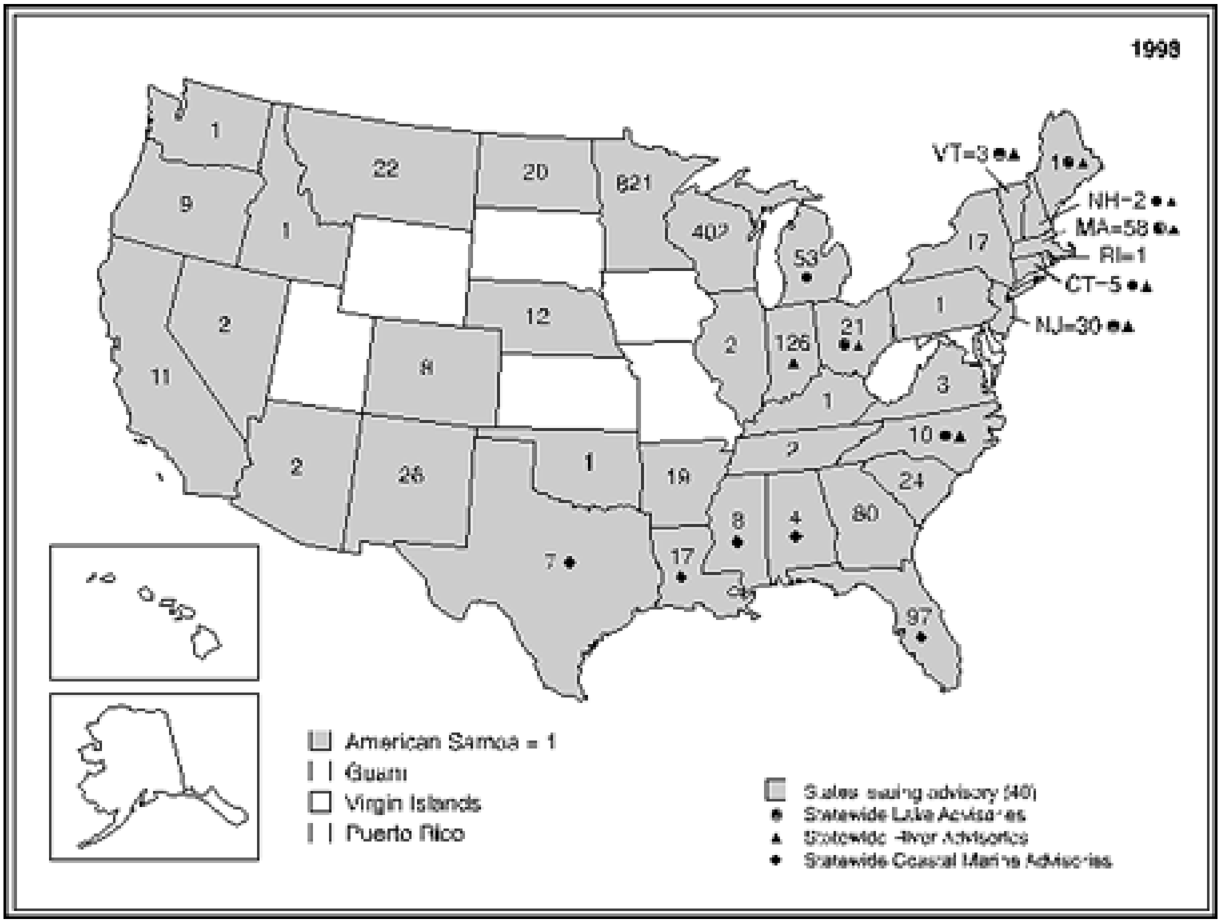
Fish Advisories

The states have primary responsibility for protecting their residents from the health risks of consuming contaminated noncommercially caught fish. They do this by issuing consumption advisories for the general population, including recreational and subsistence fishers, as well as sensitive subpopulations (such as pregnant women/fetus, nursing mothers and their infants, and children). These advisories inform the public that high concentrations of chemical contaminants, such as mercury, have been found in local fish. The advisories recommend either limiting or avoiding consumption of certain fish from specific waterbodies or, in some cases, from specific waterbody types (such as lakes or rivers).

As of December 1998, mercury was the chemical contaminant responsible, at least in part, for the issuance of 1,931 fish consumption advisories by 40 states, including the U.S. territory of American Samoa. Almost 68% of all advisories issued in the United States are a result of mercury contamination in fish and shellfish. Advisories for mercury have increased steadily, by 115% from 899 advisories in 1993 to 1,931 advisories in 1998. The number of states that have issued mercury advisories also has risen steadily from 27 states in 1993 to 40 states in 1997, and remains at 40 states for 1998. Advisories for mercury increased nearly 8% from 1997 (1,782 advisories) to 1998 (1,931 advisories).

Ten states have issued statewide advisories for mercury in their freshwater lakes and/or rivers: Connecticut, Indiana, Maine, Massachusetts, Michigan, New Hampshire, New Jersey, North Carolina, Ohio, and Vermont. Another five Gulf Coast states (Alabama, Florida, Louisiana, Mississippi, and Texas) have statewide mercury advisories in effect for their coastal marine waters. To date, 90% of the 1,931 mercury advisories in effect have been issued by the following 11 states; Minnesota (821), Wisconsin (402), Indiana (126), Florida (97), Georgia (80), Massachusetts (58), Michigan (53), New Jersey (30), New Mexico (26), South Carolina (24), and Montana (22). Figure 1 shows the total number of fish advisories for mercury in each state in 1998.

Figure 1. Fish Advisories for Mercury



Fish Consumption Limits—EPA indicated in the *Mercury Study Report to Congress* (U.S. EPA, 1997) that the typical U.S. consumer was not in danger of consuming harmful levels of methylmercury from fish and was not advised to limit fish consumption on the basis of mercury content. This advice is appropriate for typical consumers who eat less than 10 grams of fish and shellfish per day with mercury concentrations averaging between 0.1 and 0.15 ppm, which are typical for most species of commercially obtained fish. At these rates of fish intake, methylmercury exposures are considerably less than the interim reference dose (RfD) of 1 x 10^{-4} mg/kg-d. However, eating more fish than is typical or eating fish that are more contaminated, can increase the risk to a developing fetus.

Two groups of women of childbearing age are of concern: (1) those who eat more than 10 grams of fish a day and (2) those who eat fish with higher methylmercury levels. Ten grams of fish is a little over one-quarter cup of tuna per week or about one fish sandwich per week. Based on diet surveys, 10% of women of childbearing age eat five times or more fish than does the average consumer. If the fish have average mercury concentrations of 0.1 to 0.15 ppm, the women's mercury exposures range from near or slightly over the interim RfD to about twice the interim RfD.

The second group of women of concern are those who eat fish with higher mercury concentrations (e.g., 0.5 ppm and higher). Examples of fish with above average mercury levels are king mackerel, various bass species, orange roughy, pike, swordfish, shark and freshwater fish from contaminated waters. Even women eating average amounts of fish (i.e., <10 g/d) have mercury exposures near the interim RfD, if the mercury concentration is 0.5 ppm. If women eat these fish species and their average fish intake is between 40 and 70 grams/day (or about a quarter cup per day), their mercury exposures would range from three to six times the interim RfD. Consumers who eat fish with 1 ppm mercury (e.g., swordfish and shark) at the level of 40 to 70 g/d have intakes that range from 6 to nearly 12 times the interim RfD.

Some women of childbearing age in certain ethnic groups (Asians, Pacific Islanders, and Native Americans) eat much more fish than the general population. Because of the higher amounts of fish in their diets, women in these ethnic groups need to be aware of the level of mercury in the fish they eat.

The RfD is not a "bright line" between safety and toxicity; however, there is progressively greater concern about the likelihood of adverse effects above this level. Consequently, people are advised to consume fish in moderate amounts and be aware of the amount of mercury in the fish they eat.

For sensitive populations, such as pregnant women, nursing mothers, and young children, some states have issued either "no consumption" advisories or "restricted consumption" advisories for methyl-mercury. Additional information on calculating specific limits for these sensitive populations is available in EPA's Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 2, Section 3.

Table 3 shows the recommended monthly fish consumption limits for methylmercury in fish for fish consumers based on EPA's default values for risk assessment parameters. Consumption limits have been calculated as the number of allowable fish meals per month based on the ranges of methylmercury in the consumed fish tissue. The following assumptions were used to calculate the consumption limits:

- Consumer adult body weight of 72 kg
- Average fish meal size of 8 oz (0.227 kg)
- Time-averaging period of 1 mo (30.44 d)
- EPA's interim reference dose for methylmercury (1x10^{-4} mg/kg-d) from EPA's
- Integrated Risk Information System (U.S. EPA, 1999c).

For example, when methylmercury levels in fish tissue are 0.4 ppm, then two 8-oz. meals per month can safely be consumed.

Table 3. Monthly Fish Consumption Limits for Methylmercury

Risk-based consumption limit	Noncancer health endpoints
Fish meals/month	**Fish tissue concentrations (ppm, wet weight)**
16	> 0.03–0.06
12	> 0.06–0.08
8	> 0.08–0.12
4	> 0.12–0.24

3	> 0.24–0.32
2	> 0.32–0.48
1	> 0.48–0.97
0.5	> 0.97–1.9
None (<0.5)*	> 1.9

*None = No consumption recommended.
NOTE: In cases where >16 meals per month are consumed, refer to EPA's *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories*, Volume 2, Section 3 for methods to determine safe consumption limits.

Toxicity of Mercury

Pharmacokinetics—Methylmercury is rapidly and nearly completely absorbed from the gastrointestinal tract; 90% to 100% absorption is estimated. Methylmercury is somewhat lipophilic, allowing it to pass through lipid membranes of cells and facilitating its distribution to all tissues, and it binds readily to proteins. Methylmercury binds to amino acids in fish muscle tissue.

The highest methylmercury levels in humans are generally found in the kidneys. Methylmercury in the body is considered to be relatively stable and is only slowly transformed to form other forms of mercury. Methylmercury readily crosses the placental and blood/brain barriers. Estimates for its half-life in the human body range from 44 to 80 days.

Excretion of methylmercury is via the feces, urine, and breast milk. Methylmercury is also distributed to human hair and to the fur and feathers of wildlife; measurement of mercury in hair and these other tissues has served as a useful biomonitor of contamination levels.

Acute Toxicity—Acute high-level exposures to methylmercury may result in impaired central nervous system function, kidney damage and failure, gastro-intestinal damage, cardiovascular collapse, shock, and death. The estimated lethal dose is 10 to 60 mg/kg.

Chronic Toxicity—Although both elemental mercury and methylmercury produce a variety of health effects at relatively high exposures, neurotoxicity is the effect of greatest concern. This is true whether exposure occurs to the developing embryo or fetus during pregnancy or to adults and children. Human exposure to methylmercury has generally been through consumption of contaminated food. Two major episodes of methylmercury poisoning through fish consumption have occurred. The first occurred in the early 1950s among people, fish consuming domestic animals such as cats, and wildlife living near Minamata City on the shores of Minamata Bay, Kyushu, Japan. The source of the methylmercury contamination was effluent from a chemical factory that used mercury as a catalyst and discharged wastes into the bay where it accumulated in fish and shellfish that were a dietary staple of this population. Average fish consumption was reported to be in excess of 300 g/d, 20 times greater than is typical for recreational fishers in the United States.

By comparison, about 3% to 5% of U.S. consumers routinely eat 100 grams of fish per day. Among women of childbearing age, 3% routinely eat 100 grams of fish per day.

In 1965, another methylmercury poisoning incident occurred in the area of Niigata, Japan. The signs and symptoms of the disease in Niigata were similar to those of methylmercury poisoning in Minamata.

Symptoms of Minamata disease in children and adults included: impairment of peripheral vision, disturbances in sensations ("pins and needles" feelings, numbness) usually in the hands and feet and sometimes around the mouth; incoordination of movements; impairment of speech, hearing, and walking; and mental disturbances. It sometimes took several years before individuals were aware that they were developing the signs and symptoms of methylmercury poisoning. Over the years, it became clear that nervous system damage could occur to a fetus whose mother ate fish contaminated with methylmercury during the pregnancy.

Methylmercury poisoning also occurred in Iraq following consumption of seed grain that had been treated with a fungicide containing methylmercury. The first outbreak occurred prior to 1960; the second occurred in the early 1970s. Imported mercury-treated seed grains that arrived after the planting season were ground into flour and baked into bread. Unlike the long-term exposures in Japan, the epidemic of methylmercury poisoning in Iraq was short in duration lasting approximately 6 months. The signs and symptoms of disease in Iraq were predominantly in the nervous system: difficulty with peripheral vision or blindness, sensory disturbances, incoordination, impairment of walking, and slurred speech. Both children and adults were affected. Infants born to mothers who had consumed methylmercury contaminated grain (particularly during the second trimester of pregnancy) showed nervous system damage even though the mother was only slightly affected.

Recent studies have examined populations that are exposed to lower levels of methylmercury as a consequence of routine consumption of fish and marine mammals including studies of populations around the Great Lakes and in New Zealand, the Amazon basin, the Seychelles Islands, and the Faroe Islands. The last two studies are of large populations of children presumably exposed to methylmercury in utero. Very sensitive measures of developmental neurotoxicity in these populations are still being analyzed and published. A recent workshop discussed these studies and concluded that they have provided valuable new information on the potential health effects of methylmercury. Significant uncertainties remain, however, because of issues related to exposure, neurobehavioral endpoints, confounders and statistics, and study design.

Developmental Toxicity—Data are available on developmental effects in rats, mice, guinea pigs, hamsters, and monkeys. Also, convincing data from a number of human studies (i.e., Minamata, Iraq) indicate that methylmercury causes subtle to severe neurologic effects depending on dose and individual susceptibility. EPA considers methylmercury to have sufficient human and animal data to be classified as a developmental toxicant.

Methylmercury accumulates in body tissue; consequently, maternal exposure occurring prior to pregnancy can contribute to the overall maternal body burden and result in exposure to the developing fetus. In addition, infants may be exposed to methyl-mercury through breast milk. Therefore, it is advisable to reduce methylmercury exposure to women with childbearing potential to reduce overall body burden (see Fish Consumption Limits section).

Mutagenicity—Methylmercury appears to be clastogenic but not to be a point mutagen; that is, mercury causes chromosome damage but not small heritable changes in DNA.

EPA has classified methylmercury as being of high concern for potential human germ cell mutagenicity. The absence of positive results in a heritable mutagenicity assay keeps methylmercury from being included under the highest level of concern. The data on mutagenicity are not sufficient, however, to permit estimation of the amount of methylmercury that would cause a measurable mutagenic effect in the human population.

Carcinogenicity—Experimental animal data suggest that methylmercury may be tumorigenic in animals. Chronic dietary exposures of mice to methylmercury resulted in significant increases in the incidences of kidney tumors in males but not in females. The tumors were seen only at toxic doses of methylmercury. Three human studies have been identified that examined the relationship between methylmercury exposure and cancer. There was no persuasive evidence of increased carcinogenicity attributable to methylmercury exposure in any of these studies. Interpretation of these studies was limited by poor study design and incomplete descriptions of methodology and/or results. EPA has not calculated quantitative carcinogenic risk values for methylmercury. EPA has found methylmercury to have inadequate data in humans and limited evidence in animals, and has classified it as a possible human carcinogen, Group C.

All of the carcinogenic effects in animals were observed in the presence of profound damage to the kidneys. Tumors may be formed as a consequence of repair in the damaged organs. Evidence points to a mode of action for methylmercury carcinogenicity that operates at high doses certain to produce other types of toxicity in humans. Given the levels of exposure most likely to occur in the U.S. population, even among consumers of large amounts of fish, methylmercury is not likely to present a carcinogenic risk.

Summary of EPA Health Benchmarks

- Chronic Toxicity–Interim Reference Dose: $1x10^{-4}$ mg/kg-d (U.S. EPA, 1999c)
- Carcinogenicity: No carcinogenic risk values calculated

Special Susceptibilities—The developing fetus is at greater risk from methylmercury exposure than are adults. Data on children exposed only after birth are insufficient to determine if this group has increased susceptibility to the adverse central nervous system effects of methylmercury. In addition, children are considered to be at increased risk of methylmercury exposure by virtue of their greater food consumption as a percentage of body weight (mg food/kg body weight) compared to adult exposures. Additional risk from higher mercury ingestion rates may also result from the apparent decreased ability of children's bodies to eliminate mercury.

Interactive Effects—Potassium dichromate and atrazine may increase the toxicity of mercury, although these effects have been noted only with metallic and inorganic mercury. Ethanol increases the toxicity of methylmercury in experimental animals. Vitamins D and E, thiol compounds, selenium, copper, and possibly zinc are antagonistic to the toxic effects of mercury.

Critical Data Gaps—Additional data are needed on the exposure levels at which humans experience subtle, but persistent, adverse neurological effects. Data on immunologic effects and reproductive effects are not sufficient for evaluation of low-dose methylmercury toxicity for these endpoints.

EPA Regulations and Advisories

- Maximum Contaminant Level in drinking water = 0.002 mg/L
- Toxic Criteria for those States Not Complying with CWA Section 303(c)(2)(B) - criterion concentration for priority toxic pollutants:
  - Freshwater: maximum = 2.10 µg/L, continuous = 0.012 µg/L
  - Saltwater: maximum = 1.80 µg/L, continuous = 0.025 µg/L
  - Human health consumption of water and organisms = 0.14 µg/L
  - Human health consumption of organisms only = 0.15 µg/L.
- Water Quality Guidance for the Great Lakes System — protection of aquatic life in ambient water:

- acute water quality criteria for mercury total recoverable: maximum = 1.694 µg/L
- chronic water quality criteria for mercury total recoverable: continuous = 0.908 µg/L
- water quality criteria for protection of human health, drinking water and nondrinking water: maximum = 1.8×10^{-3} µg/L
- water quality criteria for protection of human health (mercury including methylmercury) = 1.3×10^{-3} µg/L.

- Listed as a hazardous air pollutant under Section 112 of the Clean Air Act
- Emissions from mercury ore processing facilities and mercury chlor-alkali plants = 2,300 g maximum/24 h
- Emissions from sludge incineration plants, sludge drying plants, or a combination of these that process wastewater treatment plant sludge = 3,200 g maximum/24 h
- Ban of phenylmercuric acetate as a fungicide in interior and exterior latex paints
- Reportable quantities: Mercury, mercuric cyanide = 1 lb; mercuric nitrate, mercuric sulfate, mercuric thiocyanate, mercurous nitrate, mercury fulminate = 10 lb; phenylmercury acetate = 100 lb.
- Listed as a hazardous substance: Mercuric cyanide, mercuric nitrate, mercuric sulfate, mercuric thiocyanate, mercurous nitrate
- Reporting threshold for Toxic Release Inventory (proposed) = 10 lb

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The 1998 update of the database *National Listing of Fish and Wildlife Advisories* is available for downloading from the following Internet site: http://www.epa.gov/OST

OST HOME | EPA HOME | WATER HOME | COMMENTS | SEARCH

URL:http://www.epa.gov/OST/fish/mercury.html
Revised September 20, 1999

VII MTBE Results

2001 MTBE Results
Units are ug/L (ppb)

The following table provides an overview of the lab results for the 2001 MTBE monitoring program.

Lake	Spring S	Spring S-1	Spring S-M	Spring S-C	Summer S	Summer S-1	Summer S-M	Summer S-C	Remarks
Black Butte	<2		<2		<2		<2		No MTBE
Eastman	0.4				3				
Englebright	<2	<2	<2	<2	<2		<2	<2	No MTBE
Hensley	1.5		1.7		2		3		
Isabella	1.4	1.3	18	0.8	3	3	3	3	Note 8
Kaweah	3		3	1.7	4		6	6	
Martis Cr.	<2				<2				No MTBE
Mendocino	<2				<2				No MTBE
New Hogan	<2				<2				No MTBE
Pine Flat	0.9		1		2		2		
Sonoma	1.9		1.6		<2		2		
Success	4		5	4	4	4	5	4	

Notes:

1. Non-Detect is indicated by "<2" since the Reporting Limit is 2 ppb or 0.002 ppm.

2. No enforceable acceptance criteria has been established for MTBE. See EPA Fact sheet.

3. Maps are provided to illustrate the sampling locations for samples: S / S-1, S-M, and S-C. Sample S and sample S1 are located near the dam; sample S-M is located within 50 ft of the Marina; and sample S-C is located near the center of the lake.

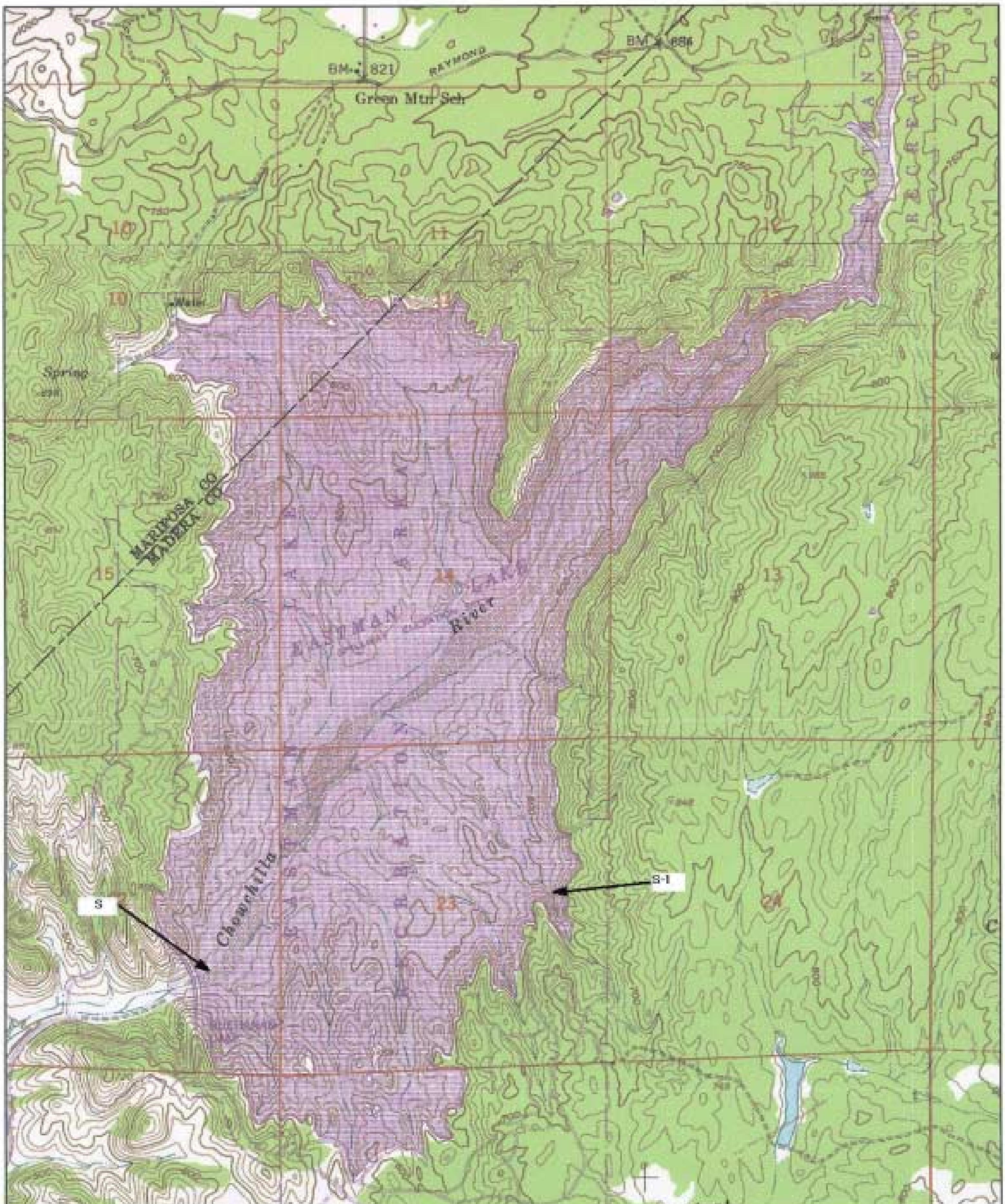
4. For 2001, the number of MTBE water sampling at each lake is based on last year's lab results.

5. 2 samples were taken from Eastman, Martis Creek, Mendocino, and New Hogan because MTBE was non-detectable for 2000. The 2001 results of non-detectable levels were similar except Lake Eastman now reported detectable levels of MTBE.

6. 4 samples were taken from Black Butte, Hensley, Pine Flat and Sonoma because relatively low detectable levels was found for 2000. The 2001 results were similar except Black Butte now reported non-detectible levels.

7. 6 to 8 samples were taken from Englebright, Isabella, Kaweah and Success because relatively higher MTBE was found for 2000. The 2001 results were similar except Englebright now reported non-detectible levels.

8. Very high MTBE was reported at Lake Isabella during the Spring for 2 straight years. During Spring 2000, Lake Isabella reported 21 ug/L. The 2001 results indicated that the high MTBE is restricted near the marina and during the Spring only. An on-site investigation will be conducted this Spring at Lake Isabella to determine the cause.


Green Mtn Sch
RAYMOND
EASTMAN LAKE
Chowchilla
River
MARIPOSA CO
MADERA CO
Spring
S
S-1

Caltest
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ORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	ANALYZED	QC BATCH	NOTES
LAB NUMBER: B040329-10							
SAMPLE ID: EA-SP-S							
SAMPLED: 12 APR 01							
METHOD: EPA 8260B							
VOLATILE ORGANIC COMPOUNDS				1	04.26.01	V010060MSB	1,2
tert-Amyl-Methyl Ether (TAME)	ND	2.	ug/L				
Ethyl-tert-Butyl Ether (ETBE)	ND	1.	ug/L				
Diisopropyl Ether (DIPE)	ND	2.	ug/L				
Methyl tert-Butyl Ether (MTBE)	J.4	2.	ug/L				
2-Methyl-2-Propanol (TBA)	ND	50.	ug/L				
Surrogate Dibromofluoromethane	80.		%				
Surrogate 1,2-DCA-d4	82.		%				
Surrogate Toluene-d8	80.		%				
Surrogate 4-BFB	85.		%				

1) Sample Preparation on 04-25-01 using EPA 5030
2) A "J" flagged result reflects a value seen below the Reporting Limit (RL), but above the Method Detection Limit (MDL).

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Caltest
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ORGANIC ANALYTICAL RESULTS

ANALYTE	RESULT	R.L.	UNITS	D.F.	ANALYZED	QC BATCH	NOTES
LAB NUMBER: B080597-8							
SAMPLE ID: EA-SU-S							
SAMPLED: 16 AUG 01 09:30							
METHOD: EPA 8260B							
VOLATILE ORGANIC COMPOUNDS				1	09.30.01	V010126MSB	1,2
tert-Amyl-Methyl Ether (TAME)	ND	2.	ug/L				
Ethyl-tert-Butyl Ether (ETBE)	ND	1.	ug/L				
Diisopropyl Ether (DIPE)	ND	2.	ug/L				
Methyl tert-Butyl Ether (MTBE)	3.	2.	ug/L				
2-Methyl-2-Propanol (TBA)	ND	50.	ug/L				
Surrogate Dibromofluoromethane	90.		%				
Surrogate 1,2-DCA-d4	81.		%				
Surrogate Toluene-d8	89.		%				
Surrogate 4-BFB	89.		%				

1) Sample Preparation on 09-28-01 using EPA 5030
2) Analysis performed past regulatory holding time.

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United States Environmental Protection Agency | Office of Water 4304 | EPA-822-F-97-009 December 1997

FACT SHEET

Drinking Water Advisory: Consumer Acceptability Advice and Health Effects Analysis on Methyl Tertiary-Butyl Ether (MtBE)

The Advisory

The U.S. Environmental Protection Agency (EPA) Office of Water is issuing an Advisory on methyl tertiary-butyl ether (MtBE)in drinking water. This Advisory provides guidance to communities exposed to drinking water contaminated with MtBE. This document supersedes any previous drafts of drinking water health advisories for this chemical.

What is an Advisory?

The U.S. EPA Health Advisory Program was initiated to provide information and guidance to individuals or agencies concerned with potential risk from drinking water contaminants for which no national regulations currently exist. Advisories are not mandatory standards for action. Advisories are used only for guidance and are not legally enforceable. They are subject to revision as new information becomes available. EPA's Health Advisory program is recognized in the Safe Drinking Water Act Amendments of 1996, which state in section 102(b)(1)(F):

> "The Administrator may publish health advisories (which are not regulations) or take other appropriate actions for contaminants not subject to any national primary drinking water regulation".

As its title indicates, this Advisory includes consumer acceptability advice as "appropriate" under this statutory provision, as well as a health effects analysis.

What is MtBE?

MtBE is a volatile, organic chemical. Since the late 1970's, MtBE has been used as an octane enhancer in gasoline. Because it promotes more complete burning of gasoline, thereby reducing carbon monoxide and ozone levels, it is commonly used as a gasoline additive in localities which do not meet the National Ambient Air Quality Standards.

In the Clean Air Act of 1990 (Act), Congress mandated the use of reformulated gasoline (RFG) in areas of the country with the worst ozone or smog problems. RFG must meet certain technical specifications set forth in the Act, including a specific oxygen content. Ethanol and MtBE are the primary oxygenates used to meet the oxygen content requirement. MtBE is used in about 84% of RFG supplies. Currently, 32 areas in a total of 18 states are participating in the RFG program, and RFG accounts for about 30% of gasoline nationwide.

Studies identify significant air quality and public health benefits that directly result from the use of fuels oxygenated with MtBE, ethanol or other chemicals. The refiners' 1995/96 fuel data submitted to EPA indicate that the national emissions benefits exceeded those required. The 1996 Air Quality Trends Report shows that toxic air pollutants declined significantly between 1994 and 1995. Early analysis indicates this progress may be attributable to the use of RFG. Starting in the year 2000, required emission reductions are substantially greater, at about 27% for volatile organic compounds, 22% for toxic air pollutants, and 7% for nitrogen oxides.

Why is MtBE a Drinking Water Concern?

A limited number of instances of significant contamination of drinking water with MtBE have occurred due to leaks from underground and above ground petroleum storage tank systems and pipelines. Due to its small molecular size and solubility in water, MtBE moves rapidly into groundwater, faster than do other constituents of gasoline. Public and private wells have been contaminated in this manner. Non-point sources, such as recreational watercraft, are most likely to be the cause of small amounts of contamination in a large number of shallow aquifers and surface waters. Air deposition through precipitation of industrial or vehicular emissions may also contribute to surface water contamination. The extent of any potential for build-up in the environment from such deposition is uncertain.

Is MtBE in Drinking Water Harmful?

Based on the limited sampling data currently available, most concentrations at which MtBE has been found in drinking water sources are unlikely to cause adverse health effects. However, EPA is continuing to evaluate the available information and is doing additional research to seek more definitive estimates of potential risks to humans from drinking water.

There are no data on the effects on humans of drinking MtBE-contaminated water. In laboratory tests on animals, cancer and noncancer effects occur at high levels of exposure. These tests were conducted by inhalation exposure or by introducing the chemical in oil directly to the stomach. The tests support a concern for potential human hazard. Because the animals were not exposed through drinking water, there are significant uncertainties about the degree of risk associated with human exposure to low concentrations typically found in drinking water.

How Can People be Protected?

MtBE has a very unpleasant taste and odor, and these properties can make contaminated drinking water unacceptable to the public. This Advisory recommends control levels for taste and odor acceptability that will also protect against potential health effects.

Studies have been conducted on the concentrations of MtBE in drinking water at which individuals can detect the odor or taste of the chemical. Humans vary widely in the concentrations they are able to detect. Some who are sensitive can detect very low concentrations, others do not taste or smell the chemical even at much higher concentrations. Moreover, the presence or absence of other natural or water treatment chemicals can mask or reveal the taste or odor effects.

Studies to date have not been extensive enough to completely describe the extent of this variability, or to establish a population threshold of response. Nevertheless, we conclude from the available studies that keeping concentrations in the range of 20 to 40 micrograms per liter (µg/L) of water or below will likely avert unpleasant taste and odor effects, recognizing that some people may detect the chemical below this.

Concentrations in the range of 20 to 40 µg/L are about 20,000 to 100,000 (or more) times lower than the range of exposure levels in which cancer or noncancer effects were observed in rodent tests. This margin of exposure is in the range of margins of exposure typically provided to protect against cancer effects by the National Primary Drinking Water Standards under the Federal Safe Drinking Water Act. This margin is greater than such standards typically provided to protect against noncancer effects. Thus, protection of the water source from unpleasant taste and odor as recommended will also protect consumers from potential health effects.

EPA also notes that occurrences of ground water contamination observed at or above this 20-40 μg/l taste and odor threshold -- that is, contamination at levels which may create consumer acceptability problems for water suppliers -- have to date resulted from leaks in petroleum storage tanks or pipelines, not from other sources.

What is Being Done About the Problem?

Research

The EPA, other federal and state agencies, and private entities are conducting research and developing a strategy for future research on all health and environmental issues associated with the use of oxygenates. To address the research needs associated with oxygenates in water, a public, scientific workshop to review the EPA's Research Strategy for Oxygenates in Water document was held on October 7, 1997.

Discussions included current, or soon to be started, oxygenate projects in the areas of environmental monitoring/occurrence, source characterization, transport and fate, exposure, toxicity, remediation, among others. The identified research will help provide the necessary information to better understand the health effects related to MtBE and other oxygenates in water, to further our knowledge on remediation techniques, and to direct future research planning towards the areas of highest priority. This document is expected to be available for external review by January, 1998. EPA plans to hold a workshop with industry to secure commitments on conducting the needed research in the Spring of 1998.

The EPA has also recently notified a consortium of fuel and fuel additive manufacturers of further air-related research requirements of industry under section 211(b) of the Clean Air Act (CAA). The proposed animal inhalation research focuses on the short and long term inhalation effects of conventional gasoline and MtBE gasoline in the areas of neurotoxicity, immunotoxicity, reproductive and developmental toxicity, and carcinogenicity. The testing requirements will also include an extensive array of human exposure research. This research will be completed at varying intervals over the next five years and could be very useful for assessing risks from MtBE in water, depending on the outcome of studies underway on the extrapolation of inhalation risks to oral ingestion.

When adequate research on the human health effects associated with ingestion of oxygenates becomes available, the EPA Office of Water will issue a final health advisory to replace the present advisory.

Monitoring

The EPA's Office of Water has also entered into a cooperative agreement with the United States Geological Survey (USGS) to conduct an assessment of the occurrence and distribution of MtBE in the 12 mid-Atlantic and Northeastern states. Like California, these States have used MtBE extensively in the RFG and Oxygenated Fuels programs. This study will supplement the data gathered in California and will attempt to shed light on the important issues of (1) whether or not MtBE has entered drinking water distribution systems or impacted drinking water source supplies, and (2) determine if point (land) or nonpoint sources (air) are associated with detections of MtBE in ground water resources. Activities are underway to begin collecting data in early 1998.

Underground Storage Tanks

Under EPA regulations, leaks from underground storage tank systems (USTs) which may cause contamination of groundwater with MtBE or other materials are required to be reported to the "implementing agency" which, in most cases, is a state agency. The EPA Office of Underground Storage Tanks and State and local authorities are addressing the cleanup of water contaminated by such leaks. All USTs installed after December 1988 have been required to meet EPA regulations for preventing leaks and spills. All USTs that were installed prior to December 1988 must be upgraded, replaced, or closed to meet these requirements by December 1998.

Safe Drinking Water Act Candidate List

The Safe Drinking Water Act (SDWA), as amended in 1996, requires EPA to publish a list of contaminants that may require regulation, based on their known or anticipated occurrence in public drinking water systems. The SDWA, as amended, specifically directs EPA to publish the first list of contaminants (Contaminant Candidate List, or CCL) by February 1998, after consultation with the scientific community, including EPA's Science Advisory Board, and after notice and opportunity for public comment. The amendments also require EPA to select at least five contaminants from the final CCL and make a determination of whether or not to develop regulations, including drinking water standards, for them by 2001. The EPA Office Water published a draft CCL for public comment in the Federal Register on October 6, 1997 (62 FR 52194). MtBE is included on the draft CCL based on actual MtBE contamination of certain drinking water supplies, e.g., Santa Monica, and the potential for contamination of other drinking water supplies in areas of the country where MtBE is used in high levels.

How Can I Get My Water Tested?

A list of local laboratories that can test your water for MtBE can be obtained from your state drinking water agency. The cost for testing is approximately $150 per sample. The analysis should be performed by a laboratory certified to perform EPA certified methods. The laboratory should follow EPA Method 524.2 (gas chromatography/mass spectrometry).

How Can I Get Rid of MtBE If It's In My Water?

In most cases it is difficult and expensive for individual home owners to treat their own water. Any detection of MtBE should be reported to your local water authority, who can work with you to have your water tested and treated.

Are There Any Recommendations for State or Public Water Suppliers?

Public water systems that conduct routine monitoring for volatile organic chemicals can test for MtBE at little additional cost, and some States are already moving in this direction.

Public water systems detecting MtBE in their source water at problematic concentrations can remove MtBE from water using the same conventional treatment techniques that are used to clean up other contaminants originating from gasoline releases, such as air stripping and granular activated carbon (GAC). However, because MtBE is more soluble in water and more resistant to biodegradation than other chemical constituents in gasoline, air stripping and GAC treatment requires additional optimization and must often be used together to remove MtBE effectively from water. The costs of removing MtBE will be higher than when treating for gasoline releases that do not contain MtBE. Oxidization of MtBE using UV/peroxide/ozone treatment may also be feasible, but typically has higher capital and operating costs than air stripping and GAC.

To Obtain the Advisory:
Call the National Center for Environmental Publications and Information (NCEPI) at 1-800-490-9198 to be sent a copy or write to NCEPI, EPA Publications Clearinghouse, P.O. Box 42419, Cincinnati, OH 45242 .

Internet download:
www.epa.gov/OST/Tools/MtBEaa.pdf

To Obtain the Research Strategy on Oxygenates in Water, External Review Draft, Contact: Diane Ray, U.S. EPA, Office of Research and Development, NCEA, MD-52, RTP, NC 27711 or by phone (919)541-3637.

Internet download:
www.epa.gov/ncea/oxywater.htm

To Obtain the 211(b) Air-Related Research Requirements, Contact:
John Brophy, U.S. EPA, Office of Air and Radiation; phone (202) 564-9068;
www.epa.gov/omswww/omsfuels.htm

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For Further Information on the Research Strategy, Contact:
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VIII Lake Code Designation

Laboratory Reports are provided in the previous sections.

Sample ID is "XX-YY-ZZ" where

XX designation:	YY designation	ZZ designation
BB for Black Butte	SP for Spring	S for surface of Lake
EA for Eastman	SU for Summar	B for bottom of Lake
EN for Englebright		I-1 for inflow1
HE for Hensley		I-2 for inflow 2
IS for Isabella		O for outflow
KA for Kaweah		
ME for Mendocino		
MC for Martis Creek		
NH for New Hogan		
PF for Pine Flat		
SO for Sonoma		
SU for Success		

Example: EA-SU-S is for a water sample taken from Eastman in the Summer on the Lake's Surface.